MACHINERY.

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THE HEATING AND VENTILATION OF MACHINE SHOPS.*

CHAS. L. HUBBARD.†

IN the previous articles, published in the October, November and December, 1905, and the March, 1907, issue, fans and heaters have been treated in some detail without reference to their specific uses in connection with any particular class of buildings. It is now proposed to take up the methods of air distribution, and show the application of hot-blast heating to machine shops and other buildings of similar construction. In order to make the present article complete in itself, some of the data already published will be repeated in condensed form. This is especially for the benefit of those who may not have the articles above mentioned on file.

Methods of Heating.

The older method of heating a shop was by means of steam coils, either run along the walls under the windows, or supported overhead as most convenient. This arrangement necessitates a large amount of heating surface together with an extended system of supply and return piping, thus greatly increasing the liability to leaks and freezing. This method provides no fresh air for ventilation, and the distribution of heat is not of the best. When the coils are placed along the walls, under benches, it is uncomfortably warm for those working near them, and if supported overhead, the heat rises directly to the ceiling or roof, thus leaving the lower portion of the room too cold.

The most satisfactory arrangement is where the heating is done by hot air properly distributed through suitable ducts and flues. The heating surface in this case is very compact, only about one-fifth of that required for direct heating being necessary; and as the surface is grouped in a single heater, even in buildings of large size, long runs of piping are avoided. In the largest plants, or where the buildings are more or less detached, it becomes necessary to increase the number of units, but even then the pipe runs are simple compared with those necessary for direct heating. A better distribution of heat is obtained, resulting in a more uniform temperature throughout the rooms. As heating systems of this kind are usually arranged for taking a portion of their air supply from out of doors, it is possible to secure any degree of ventilation required.

General Arrangement.

The location of the fan and heater and the general arrangement of the distributing ducts will depend largely upon the construction and plan of the building. One of the simplest arrangements for a building of small size is that shown in Fig. 2. In this case a single galvanized iron uptake is carried from the mouth of the fan directly upward through the different stories of the building. At each floor the requisite number of outlets are provided at or near the ceiling level, and the air discharged toward the outer walls. In the case of a larger building it would be necessary to extend the distributing ducts horizontally from the main uptake, as shown in Fig. 3.

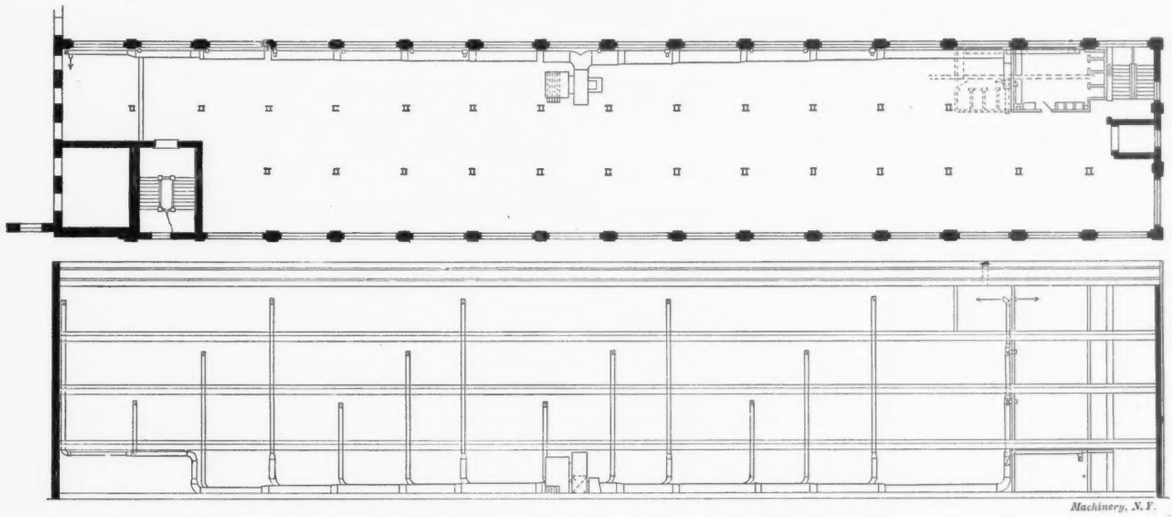

Fig. 1. Heating and Ventilating System of the Ashcroft Manufacturing Company, Bridgeport, Conn.

Another typical arrangement is that shown in Fig. 1, which represents the plan and elevation of the heating and ventilating system installed in the shops of the Ashcroft Manufacturing Company, of Bridgeport, Conn. In this arrangement the fan and heater are centrally located in the basement near one of the side walls. Main distributing ducts are carried in both directions near the floor, and from these, vertical risers are taken off at frequent intervals and carried up to the different stories. The air is discharged into the rooms horizontally at an elevation of about eight feet from the floor. Regulating dampers are provided in each uptake for proportioning the air flow through each outlet.

Fig. 8 shows a plan and elevation of the fan and heater. The fan is of the centrifugal type, with bottom horizontal discharge. The wheel is 6½ feet in diameter, and is driven by a 7-inch by 7-inch vertical direct-connected engine. The heater is made of 1-inch pipe, twenty-two rows deep. The sections are 6½ feet wide by 8 feet high. The building is warmed by air-rotation, no connection being made with the outside air.

Figs. 5 and 6 show plan and sectional elevation of a different arrangement, as installed in the shops of the Houston, Stanwood & Gamble Co., at Covington, Ky. In this case the fan and heater are placed in one corner of the building, and the air carried across one end in an underground concrete

* The following articles on the subject of heating and ventilation have previously appeared in MACHINERY: Boiler Horse-Power for Heating and Power, February, 1903; Notes on Forced Blast Heating Systems, June, 1903; Fans, October, November and December, 1905; Heaters for Hot Blast and Ventilation, March, 1907.

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duct. Two uptakes connect with this, running up beside columns supporting the roof; horizontal branches are then carried the entire length of the building, one on each side, passing through the roof trusses as shown. The air is discharged through short mouthpieces set at an angle to give it a downward direction, and arranged to deliver it both to the central portion and the side aisles or bays. This particular arrangement of the distributing ducts is made necessary on account of the traveling cranes which pass through the entire length of the building in each of the three sections as indicated by tracks at the sides in Fig. 5. This is a typical illustration of an overhead distribution, the air being discharged at an elevation of about 18 feet above the floor. The apparatus in this case also takes its air supply from the building, leakage being depended upon for ventilation.

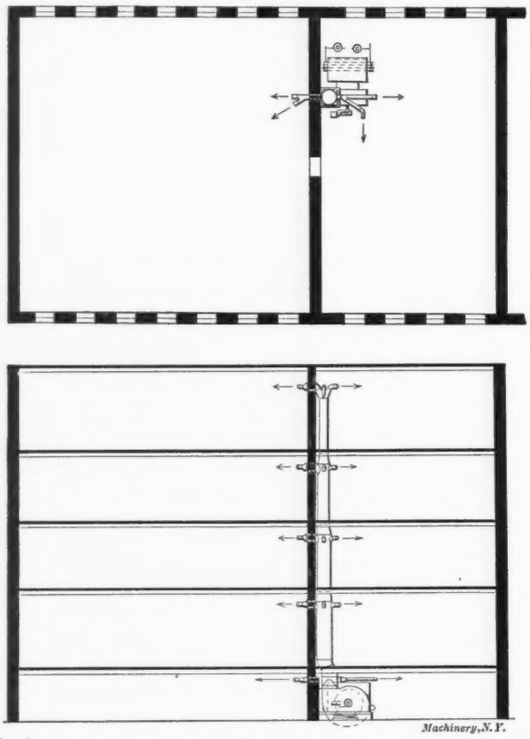

Fig. 2. Simple Arrangement of Heating Installation of a Small Building.

Fig. 9 shows a plan and elevation of the fan and heater. The fan is of the three-quarter housed type, with a bottom horizontal discharge connecting with the underground duct. The wheel is 9 feet in diameter. The heater is made up of two groups, with a supply and return header at each side. It is 20 pipes deep, and has an exposed front 8 feet high by 12½ feet wide.

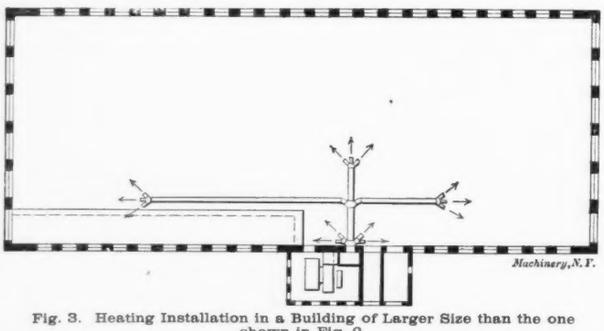

Fig. 3. Heating Installation in a Building of Larger Size than the one shown in Fig. 2.

Fig. 7 illustrates a somewhat similar arrangement, although in this case two overhead units are used, each made up of two fans and a heater, and the air is carried downward to a point about 8 feet from the floor before being discharged. The system is installed in the machine and erecting shops of the Pennsylvania Railroad Company at Trenton, N. J. All parts of the system are symmetrically arranged, which gives practically an equal resistance to the flow of air in each of the four main distributing ducts.

A plan and elevation of the fan and heater of one of the units is shown in Fig. 4. Two double inlet fans are used, with wheels 8½ feet in diameter attached to a common shaft and driven by a belted motor. The heater is made up with a double header, as in the previous layout. It is 20 pipes deep, 13½ feet wide and 10 feet high. The air is taken from the building, but is forced through the heater instead of being drawn through by suction, as in the other arrangements shown.

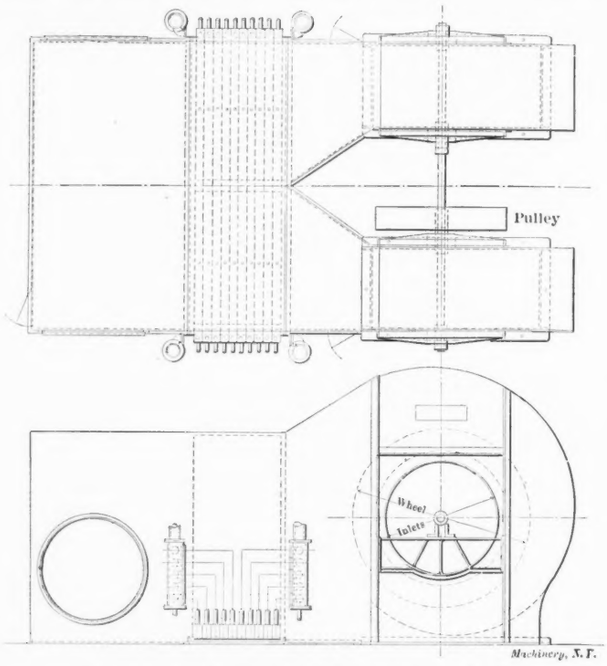

Fig. 4. Fan and Heater of Installation shown in Fig. 7.

These five buildings illustrate the more common methods of arranging the distributing systems in the heating of machine shops of modern construction. They were designed and installed by the B. F. Sturtevant Co., of Boston. Having shown examples illustrating the general layout of a system for shop heating, let us now take up some of the details of design.

Material used for Ducts and Flues.

The airways are either constructed of brick or galvanized iron. In brick buildings where the heating system is planned before the building is constructed the flues may be most readily and economically built in the walls as the building is erected. When this is done, care should be taken to give them as smooth an interior as possible by removing all projecting mortar from between the bricks.

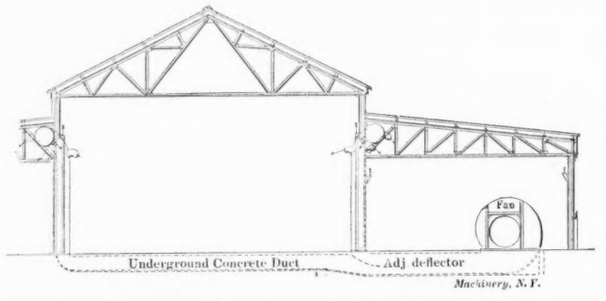

Fig. 5. End Elevation of Installation shown in Fig. 6.

Underground ducts are built either of brick or concrete for the larger sizes, and generally of glazed tile for the branches. In buildings of wooden construction, and also those of brick when erected before the heating system is laid out, it is customary to use galvanized iron. This is easily worked into the required form, is light in weight, and takes up a minimum of space for a given area.

Construction of Ducts and Flues.

Great care should be taken in the design and construction of a system of ducts and flues. When a change in the di-

rection of flow is necessary, a gracious curve should be provided. For 90-degree turns, the elbow should be made with at least five pieces, and the radius of the inner side of the elbow should not be less than the diameter of the pipe. This relation between the radius of curvature and the size of pipe should hold in the case of rectangular ducts as well.

When a branch is taken off from a straight run of pipe, it should be given an angle of 45 degrees at the point of connection, and the remaining change in direction made by

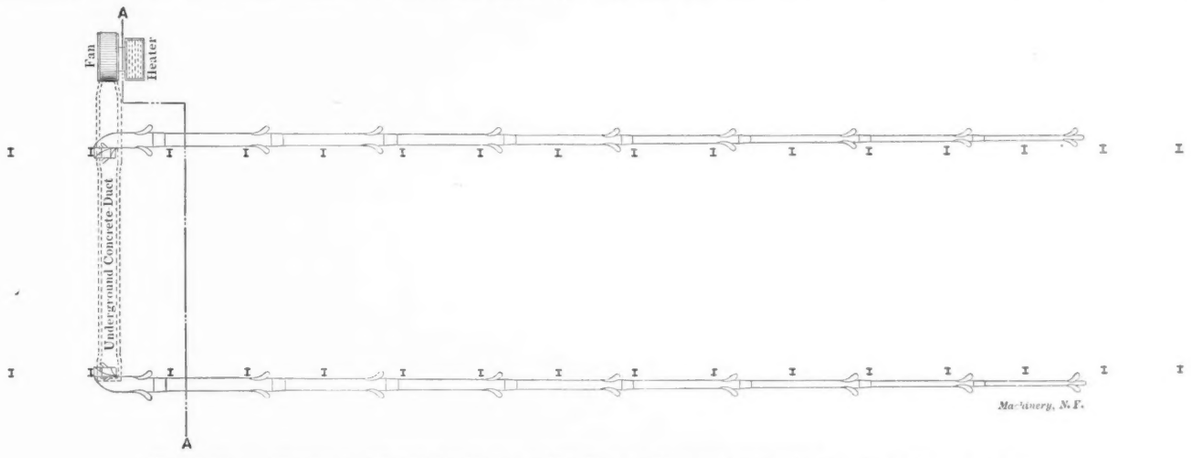

Fig. 6. Plan of Heating and Ventilating System of the Houston, Stanwood & Gamble Co., Covington, Kentucky.

an easy turn. The main run of pipe is commonly reduced at each branch or take-off by an easy taper, about 28 inches in length, which can be made from a sheet of iron of standard width, which is 30 inches. Whenever the duct or pipe branches, the construction should be such as to divide the air volume into the required proportions, giving to each branch an easy change in direction, when possible. While due regard should be given to the proper proportioning of the pipe areas, it is not possible to get a sufficiently accurate distribution of air without the use of dampers and deflectors. In the case of a large number of small outlets from a main duct, the best results are usually obtained by the use of adjustable dampers in each outlet. Where there are several branches of considerable size leading from the main, it is well to place adjustable deflectors at the junction of the ducts, so that the air volume can be deflected into the branches in such quantities as may be desired. In the case of brick or concrete underground ducts, the same points relating to curves, dampers, etc., should be observed as described above for galvanized iron.

Size of Ducts and Flues.

The sectional area of the ducts and flues is based upon the velocity of the air flow through them. It is a well-known fact that the frictional resistance to the flow of air through pipes increases as the square of the velocity, hence if the power required for driving the fan was an important factor, very low velocities would be required. As a matter of fact, this is generally neglected in practice, and velocities are based upon the most desirable speed of fan for this class of work, which is about 5,000 linear feet per minute tip velocity. This results in a velocity through the fan outlet of about 3,500 feet per minute. The size of the main duct is made such that the velocity commonly runs from 2,000 to 3,000 feet per minute, although some engineers make a practice of starting with a duct the same size as the fan outlet, but making a small increase in the size of the branches, so that their aggregate area shall be from 30 to 40 per cent greater than the area of fan outlet, thus bringing the velocity down to from 2,500 to 2,800 feet per minute.

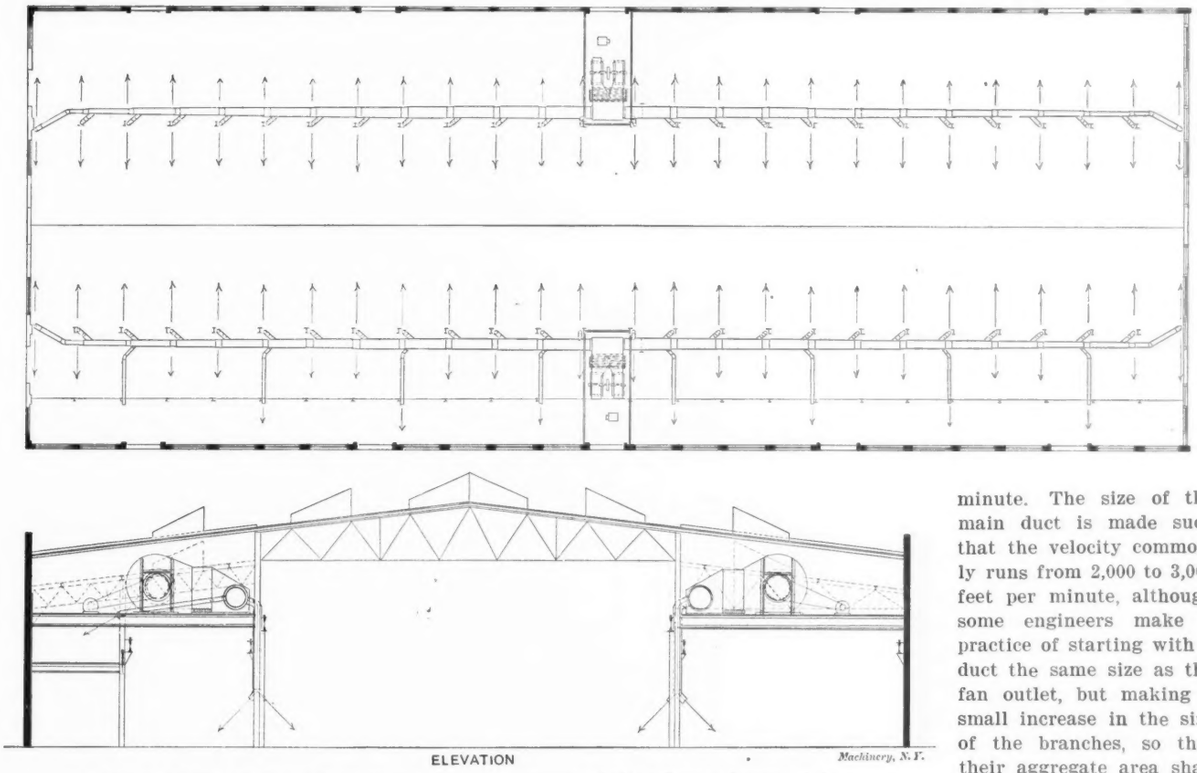

Fig. 7. Heating System of Pennsylvania Railroad Company's Machine Shop at Trenton, N. J.

It is frequently possible in shop practice to secure satisfactory circulation of the air with a limited extent of ducts by discharging it at a high velocity, as noted above, thus compelling it to continue its direction of movement for a consider-

able distance without the use of conducting pipes. It is not uncommon in such cases to force the air 100 feet or more from the outlets at a velocity of 2,000 to 3,000 feet per minute.

Weight of Iron Used.

Table I gives the gage of iron commonly used for pipes of different diameter. All sizes above 60 inches are made of No. 16 gage. If the pipe is made much lighter, particularly in the larger sizes, it will not keep its shape when supported horizontally, which results in loosening the joints and also decreasing the area of the pipe. The common practice is to make rectangular pipes of the same gage as round pipes having the same sectional area, but under certain conditions, as in the case of a thin, flat pipe, bracing is necessary to prevent sagging, even with heavy gages. When braces are used, lighter iron may be used than given in the table.

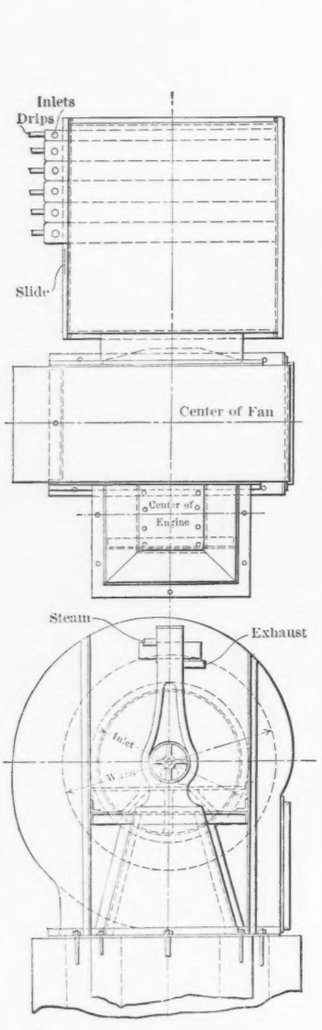

Fig. 8. Fan and Heater of Installation shown in Fig. 1.

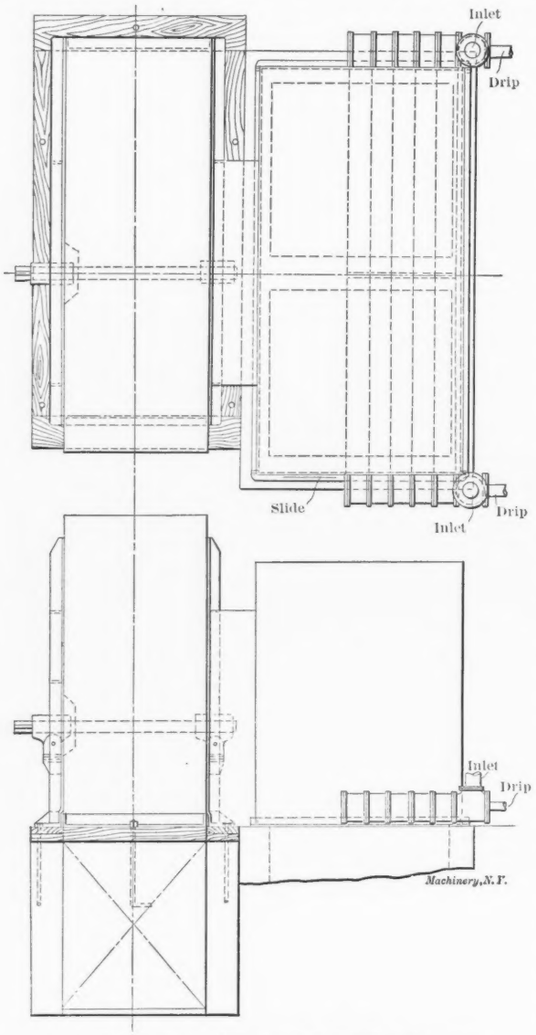

Fig. 9. Fan and Heater of Installation shown in Figs. 5 and 6.

Heaters.

The subject of heaters for shop heating was quite thoroughly discussed in MACHINERY for March, 1907. A few of the results noted there will be given in the present article together with some special reference to heating by air rotation. In shop practice, the amount of heating surface is generally expressed in linear feet of one-inch pipe for a given space to be heated. This, for average conditions, may be taken as follows. With all of the air taken from out of doors, there is generally allowed 100 cubic feet of space for one foot of pipe when exhaust or low-pressure steam is used, and 150 cubic feet with steam at 80 pounds pressure. When the building is heated by air rotation, the above figures may be raised to about 140 and 200 for low-pressure and high-pressure steam, respectively. The heater is generally made about twenty pipes deep under ordinary conditions. Heaters of this type have an efficiency of about 1,300 heat units per square foot of surface for steam at 5 pounds pressure, and an efficiency of 1,600 for 60 pounds pressure.

TABLE I.

Diameter of Pipe.	Gage of Iron
Less than 9 inch	28
9 inch to 14 inch	26
15 inch to 20 inch	25
21 inch to 26 inch	24
27 inch to 35 inch	22
36 inch to 46 inch	20
47 inch to 60 inch	18
61 inch and above	16

Volume of Air Required.

When the air is taken from out of doors for the purpose of ventilation, it may be based upon the number of occupants or upon a given number of air changes per hour. Usually the cubic contents is large per occupant and may vary considerably in different shops, so that under ordinary conditions it is best to use the former method. The air supply per occupant may be taken as about 25 or 30 cubic feet per minute, unless the building is very openly constructed, in which case the air volume may be reduced and leakage depended upon to a considerable extent. In many shops the heating is done entirely by air rotation, and leakage is depended upon entirely for ventilation. This is made possible because of the large enclosed space in proportion to the number of occupants and to the thorough mixture of the inleaking air with that which is in rotation. When this method of heating is used, the air simply becomes the medium for transferring the heat to the different parts of the building, and the volume required will depend upon the amount of heat to be transferred and the temperature to which the air is raised.

Suppose the air is returned to the heater at a temperature of 60 degrees and delivered at a temperature of 140 degrees, the total rise being 80 degrees. In cooling one degree, one cubic foot of air gives out 1/55 of a heat unit, or in cooling 80 degrees will give out $1/55 \times 80 = 80/55$, or 1.4 heat unit. Therefore, if we divide the total amount of heat to be supplied in a given time, expressed in heat units, by 1.4, it will give the volume of air to be rotated in that time, assuming, of course, that it is cooled through 80 degrees during its passage through the room.

The heat loss from the building may be computed by any of the common methods in use, or the size of the heater may first be computed by the method already given, and the heat given off taken as the equivalent of the heat lost. Referring to Table II in MACHINERY for March, 1907, we find that a heater twenty pipes deep with steam at 5 pounds pressure will raise the temperature of air from 0 to 140 degrees, and has an efficiency of 1,300 heat units. Steam at 5 pounds pressure has a temperature of 227 degrees. The average temperature of the air passing through the heater is $\frac{0+140}{2} =$ 70 degrees, hence the difference in temperature between the steam and air is $227 - 70 = 157$ degrees. In case the air is rotated, its average temperature is $\frac{60+140}{2} = 100$ degrees,

and the difference between the steam and air is 227 — 100 = 127 degrees. The efficiency of a heater varies directly as the difference between the temperature of the steam and air; hence, in the second case, with the air rotated, the efficiency would be 157 : 127 = 1,300 : x, and x, the efficiency in this case, would be approximately 1,100 heat units. Then the square feet of surface in the heater multiplied by 1,100 will be the heat given off per hour, and this divided by 1.4 will give the cubic feet of air to be moved per hour by the fan.

Size of Fan.

The required size of fan for moving any given volume of air may be taken from Table II, which also gives the approximate speed and the horse-power required for driving the fan.

TABLE II.

Nominal Size of Fan, Height of Housing in Inches.	Diameter of Fan Wheel in Inches.	Width of Housing in Inches.	Ordinary Speed Giving ½ Ounce Pressure.	Cubic Feet of Air Delivered per Minute.	Horse-power of Engine to Drive the Fan.
30	18	9	870	1000	½
40	24	12	580	1600	1
50	30	15	465	2600	1
60	36	18	390	4500	2
70	42	21	333	6000	2½
80	48	24	293	8000	2½
90	54	28	260	11000	4
100	60	32	233	12500	4
120	72	43	195	21500	7
140	84	48	167	28600	9
160	96	48	147	31800	10
	108	54	130	40400	13
	120	60	117	51000	16

The speeds given in the table are for ½ ounce pressure; should it be desired to deliver the air under a higher pressure, in order to force it a long distance from the outlets, it would be necessary to increase the speed of the fan somewhat, depending upon local conditions.

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NOVEL HIGH COMPRESSION OIL ENGINE.*

ALFRED GRADENWITZ.†

In oil engines of the injection type, the liquid fuel, as is well known, is injected in an atomized condition immediately into the combustion chamber, where an immediate ignition and combustion takes place owing to the heat from the previous compression of the air. Now the main difficulty met with in the construction of these motors has been to conveniently atomize the fuel, and to produce the highly compressed injection air which is indispensable for the process. This air must be raised to a pressure superior to the terminal compression in the clearance space, in order to pick up the oil and spray it in a finely subdivided state into the combustion chamber.

In the Trinkler motor, recently brought out by Messrs. Körting, Ltd., this is neatly and efficiently effected by the aid of a small auxiliary "injection" piston, which, towards the end of the compression, separates a certain amount of compressed air from the clearance space, driving it with the necessary injection pressure through the injection nozzle, along with the oil contained in the latter, into the combustion chamber. The construction of this motor will be understood by reference to Figs. 1 and 2, and the accompanying description.

The Trinkler engine is a single-action four-cycle motor, with a working stroke on every alternate rotation, the working process being as follows: The piston A, on the out stroke, draws in through the inlet valve pure air, which it compresses on the return stroke to a pressure of from 28 to 30 atmospheres. At the same time the compartment *D*, situated in front of the injection piston *C*, will be filled with compressed air from the cylinder through a compensating channel *E*, which connects this compartment with the clearance space. Through channel *G*, at the same time, the compressed air flows into injection nozzle *F*, which permanently communicates with the compression chamber through a relatively small injection aperture. A charge of liquid fuel is stored in the chamber of the injection nozzle *F*, being supplied to it through a valve *I* from a fuel pump, connected with the valve through the conduit *K*.

Toward the end of the compression stroke, the injection piston *C* (owing to the difference in pressure on the front surface turned toward the compression compartment and the annular surface formed by the piston rod of the injection piston) will be rapidly moved outward, sliding across the channel *E*, and separating the air in compartment *D* from that in the cylinder. With the further motion to the left of piston *C*, this amount of air is forced from the chamber *D* through conduit *G* and injection nozzle *F* back into the combustion chamber again. As the mouth *H* of the nozzle is relatively narrow, while the motion of the piston *C* is extremely rapid, the injection air will be highly compressed, and will traverse the injection nozzle *F* of the fuel-storing compartment with a

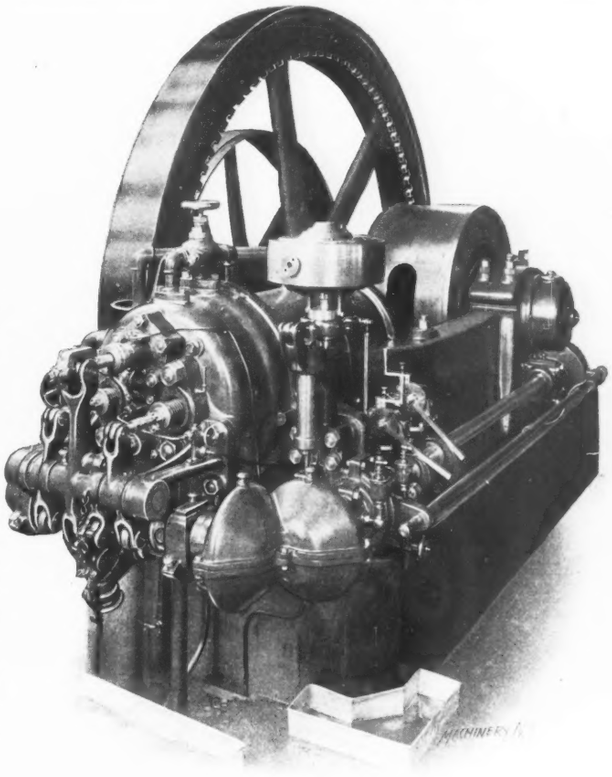

Fig. 1. The Trinkler Oil Engine.

high speed, so as to carry along the fuel and to throw it in a state of finely atomized spray into the combustion chamber, in which, owing to the high temperature of the compression, the fuel will be ignited, whereupon piston *A* will be thrown forward, transferring the impulse to the crank. Shortly before the end of the working stroke, the outlet valve will be opened by the valve gear, and the products of combustion will be exhausted on the return stroke of the piston. During the subsequent advance of the piston, the suction and further working processes will be repeated as above described.

The motor is started by means of compressed air, supplied to the engine through a mechanically controlled valve *N*. The compressed air reservoir used for this is charged from the compression space of the engine itself through a charging valve (not shown) cooled by the jacket water.

The high thermal efficiency of oil injection engines is generally known. As regards the other features of these motors, the absence of any igniting or heating apparatus should be noted, as well as the perfect elimination of soot and smell, due to the perfect combustion of the fuel. As regards their ease of operation, and the safety and elasticity of the service, these engines may be said to equal those using gas fuel, while

* For further information on internal combustion engines, see the following articles previously published in Machinery: The Oil Engine, September 1898; The Commercial Advantage of the Oil Engine, June, 1899; An Interesting Engine, May, 1899. Internal Combustion Engines and the Diesel Principle, September, 1904. Patents in their Relation to the Gas Engine and the Automobile, January, March, and May, 1906; Oil Engines, August, 1907; The Johnston Crude Oil Engine, August, 1907.

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far excelling from the former point of view the steam engine. One of the main special advantages of the Trinkler motor is the simplicity of the injection apparatus, which is free from any valves and special pressure reservoirs. The motor, thus, is free from any part requiring to be packed permanently against high pressure. As the fuel pump has not to work against high pressure, the ease of regulation of this motor is especially remarkable.

The most valuable feature of this novel engine is its extremely low fuel consumption, both with full and partial loads. According to tests made by Prof. E. Meyer, of the Charlottenburg Technical Institute, a 12-horse-power motor of this type showed in permanent operation a consumption of 0.4863 pound Russian crude naphtha per hour and effective (metric) horse-power. The minimum heating value of the crude oil in question was found to be 9,863 thermal units per kilogramme. The engine thus used up 2,180 thermal units per effective horse-power hour, corresponding to a thermal fuel efficiency of 29.2 per cent. This is the more remarkable, as the consumption of fuel with half load was found to be only 7½ per cent higher than with full load, that is to say, 0.524 pound per hour.

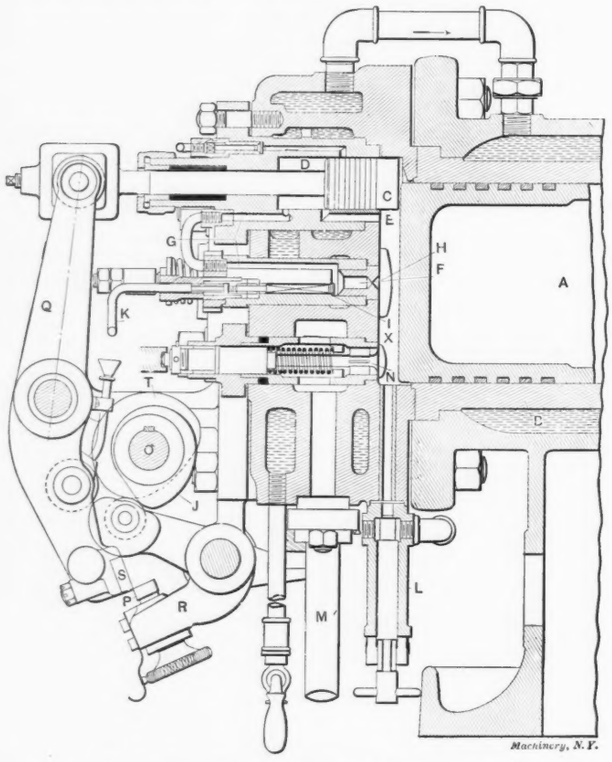

Fig. 2. Cross Section through Oil Injection Mechanism.

[Two or three other points of interest besides those mentioned by Dr. Gradenwitz, may be noted from a survey of the cuts. The auxiliary piston *C* is evidently moved to the right positively, by arm *Q* and cam *T*. It is then held in this position by the engagement of latch *P* against the hardened block *S* at the lower end of lever *Q*. As piston *A* approaches the end of the compression stroke, at the proper moment cam *J* presses down lever *R* and latch *P*, releasing lever *Q*, and allowing piston *C* to move to the left as described, under the influence of the pressure in the compression space *X*. On the release of lever *Q*, the spraying of the fuel and its consequent ignition take place almost immediately. Owing to this, the time of ignition can be regulated by changing the time of release of the lever *Q*. This is done by making latch *P* adjustable by the knurled thumb screw shown. The speed of the engine is regulated by the action of the governor on the fuel pump, which is thus made to furnish a greater or less charge to the nozzle, as may be required.—EDITOR.]

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A brass much used in marine vessel construction, because of its excellent resistance to the corrosive action of sea water, is 1 part tin, 39 parts zinc, and 60 parts copper.

EDUCATION FOR INDUSTRIAL WORKERS.*

A PLEA FOR A MACHINE TRADE SCHOOL.

ARTHUR D. DEAN.†

There are several movements now on foot for the establishment of trade schools. One is that initiated by the schoolmaster. He states that boys do not remain in school long enough, and that some scheme of education must be devised whereby they will remain after the legal limit imposed by the compulsory attendance laws. He claims that they leave school at 14 and waste two years drifting along lines of work which do not give them an economic hold on the industrial life. I regret that the schoolmaster advocates for these boys only manual training when I believe that he should propose trade training for them. I regret that he impresses upon the public that the public school does not and will not teach a trade. He states that the shop work in the schools is to teach only the mechanical principles underlying the trades, and these merely for their educational value. Only 6 per cent of 2,500 graduates of our manual training high schools have become mechanics.

Need of a New Type of Trade School.

This result may justify the existence of the manual training high school, and at the same time it strongly points to the need of another type of school which will teach the youth of our land to become *first-class mechanics*. I believe it is the proper function of the school official to advocate a type of school which in its purpose frankly and openly states that it can and will fit a boy for a good workman at a chosen trade. Our head workers must come from the ranks if we are to get the best work out of these workers. To eliminate the chances for promotion which give a worthy purpose for ambition and foresight by taking into our industrial system foremen and superintendents outside of the ranks is to crush the workers, and eventually kill the industrial system. The phrase "room at the top" must not lose its significance through closing the entering door by taking into the industrial system too many men trained outside the industrial ranks.

Among the objections to trade schools is that they cannot teach a trade, and that the only place to learn a trade is in the shop. I believe that this statement is unfair, as the few trade schools which exist have demonstrated that a trade can be taught as a part of an educational system, and the graduates have gone into the shops and made good. I do not claim that they can learn all that concerns a trade in any school. Neither do they learn all there is to a trade in a shop. It is a self-evident truth that no man learns all that there is to a trade or profession, no matter where he receives his training nor how long he practices it. It seems to me that definite organized instruction in the use of various tools and machines in a trade school will turn out workers superior to those who, like Topsy, simply "grew up" in such manufacturing establishments, which take no pains to give systematic instruction to their young workers.

Why an Ideal Trade School can Develop Better Mechanics than the Shop.

Let us consider some of the reasons why a trade school can render better service than the average shop in developing skilled mechanics.

1. The school can help make a profitable workman in a shorter time by giving him, under instruction, legitimate shop practice in the work of the trade. Definite practice in the work of the trade from the very beginning in a school is a far different proposition from sweeping, piling castings or running errands for several weeks or months in the shop.

2. The school can give a series of graded lessons, general and fundamental, upon which other work may be based, and future efficiency more certainly developed. The lack of sequence in the ordinary shop work becomes for the average boy merely routine work, and he flounders around.

* The subject of industrial education and kindred subjects has been treated previously in the following articles in MACHINERY: Technical Education, January, 1901; Technical Education, December, 1903; Contemporary Technical Education, January, 1905; Factory Education, December, 1905; An Experiment in Industrial Education, January, 1906; An Experiment in Industrial Training, September, 1906; A Step Toward Increased Facilities for Industrial Education, December, 1906; Vital Needs of Evening Schools for Industrial Workers, January, 1907; Apprenticeship Education, February, 1907; Unique Experiment in Technical Education, March, 1907; Promoting Industrial Education, May, 1907.

† Address: 167 Tremont St., Boston, Mass.

3. The school can give the opportunity to do a task over and over again until it is done right, the opportunity to study each problem closely and deliberately. In a shop there is little chance to try again. The work must be thrown away. A "call down" in a shop can never take the place of *definite instruction* in a school.

4. The school can give a broader, more intelligent idea of the relation of the parts to the whole. The beginner learns the dependence of one part on another. The tendency to keep a cheap grade of labor doing one thing may make a first-class operator, but if we expect our bright boys to respond to an unusual problem, they must have a chance to practice all the usual operations of production.

5. In the school the instruction is direct and personal, given by one who is selected not only because of his superior qualities as a workman, but because of his ability to teach. The instruction in the average shop is haphazard and accidental, given by a foreman who is already harrassed by a multiplicity of details.

6. The school comes nearer to taking the place of the shop as it approaches the commercial standards of the shop. The incentive of the commercial demands of the shop will emphasize the value of time. A clear conception of how a piece of work should be done is necessary at the outset to avoid a waste of time.

Municipal Authorities Slow to Respond.

To hope that municipal authorities will take the initiative with reference to trade schools is expecting too much, for unfortunately some politicians only see the popular mind of the people through the eye of the labor leader, and labor leaders are opposed to trade schools. There will also be difficulty in disposing of the finished products of these schools if they are under municipal auspices. In order that the work may be of a thorough, practical sort, it must illustrate actual trade conditions. The parts must be assembled into a complete machine in order to illustrate all the commercial processes. When these machines are complete, they must be disposed of in the market. If we bear in mind the past experience of some state reform schools which have attempted to dispose of their products and have been prevented from so doing, and finally have given up their industrial and trade work, one can readily see that the disposition of the finished product becomes a real and serious problem.

Private Trade Schools Needed for Purpose of Illustration.

We need a few trade schools to serve as practical illustrations of what they are capable of doing. We need schools which can practically answer the statements that a trade can be learned in a school, and that trade schools are a benefit to the working man. We must show what a trade school is like. I believe that these schools must pass through the same experience which was undergone when cooking, manual training, and kindergarten schools were established. They were introduced at first under private auspices, and demonstrated their value before they were accepted by the mass of the people. I am a believer in the theory that *private initiative creates public enterprise*, and that no better service can be done than to educate through private trade schools the public conscience to the point where it will see some practical examples of their value. In the preliminary development the trade school movement will go forward only when it is a private enterprise. These schools must have the interest of the manufacturer. They must have his suggestions. He has been the largest factor in industrial development. He recognizes that the trade school can substitute definite systematic instruction for the haphazard, uneconomic training in those shops where no special effort is made to train industrial workers. Practical men know that special education for a trade, accompanied by training in mechanics, mathematics, science, and precepts of clean living, will serve as a basis for stable equilibrium for the industrial world, now so often upset through industrial strife.

The two points to keep in mind in all this discussion of trade schools are first, the American boy who is desirous of an opportunity to learn a trade, and second, the establishment of a school which will give him such training.

Naturally you want to know what sort of a definite proposition I can present, and so, as an illustration, I offer the following suggested outline for a trade school preparing students for the machine trades.

Should have no Other Name but Trade School.

In regard to its nomenclature it must be called a trade school. It must not be called an industrial school or a preparatory school for the trades. Its name should not cover up the character of the work which it intends to do. It should in its very name define the nature of its proposed work. There should be no hesitation in calling it just what it is.

Schools not to Create Class Distinction.

Naturally the question arises, what class of students will be taken into the school. The students should be recruited from any class wherein an individual feels that a knowledge of a trade will be of value to him. In all probability the great majority of recruits would come from the rank and file of workers, and the whole atmosphere of the school should be such as to make them feel that its work was for their benefit. It must be a school which will instil in the minds of the boys the idea that they are going to become workmen, and good workmen at that, and that if they are good workmen they may become superintendents and foremen. It must avoid starting them out with the idea that they are to be superintendents and foremen immediately upon graduation. It should awaken in them a desire to be *good workmen*.

School Schedule Same as Shop Schedule.

The school should run eleven months in the year, fifty hours a week, or in other words should imitate the hours and holidays of the factory. The hours and working days being practically the same as those in the shop would teach the students habits of regularity which they must learn in actual employment. I would suggest that the month of August be taken as a shut-down period. This does not imply a vacation, but rather an opportunity for making necessary repairs for next year's work. Boys in the school who need money should be hired to do this repair work.

Should be Open both Day and Evening.

The school should be open both day and evening, although whether such a school could be run successfully for two kinds of work depends entirely upon its organization. To run it successfully both day and evening would require practically a double force of instructors. This, however, is a detail in organization. The day class should be composed of boys who have been secured with a great deal of care as regards mental and physical fitness for the future work which they are to do. They should be taken into the school for a trial period of three months. They should be set at work the very first thing on a job which will test their ability to do mechanical work. Sweeping floors may demonstrate a boy's ability to sweep, but it will not point out to the school managers his ability to make a good mechanic.

The school should be open evenings for young men who wish to advance themselves in their trade. Few, however, will care to spend their evenings in the same class of work in which they are engaged during the day. This departure will reach fellows of a different caliber, whose qualities of mind and mechanical ability cannot be judged by written entrance examinations. Their fitness to enter the school can be determined by a practical examination in one or two pieces of shop work and a five minute interview in order to size up their characteristics.

Kernel of Instruction should be Shop Practice.

The kernel of instruction should be shop practice and book learning which fits in with the machine trades. This means that the major subject will be machine shop practice. It also means that there must be some mechanical drawing, pattern making and molding. The course of instruction will not be complete unless there is academic work in English, business forms, mechanics, arithmetic and physical science. The instruction in all this work must be carried on expressly to meet the needs of the machine trades. It must not be taken from elaborate text-books in general arithmetic, general English, etc., but rather from courses which have been carefully worked out by practical men who know what topics are of vital importance to a boy who is to be engaged in a machine trade. Incidentally, there should be inculcated in the minds of the students a power to reason on social and economic

problems along lines which will give them that proper point of view so necessary in these days of the relation of their individual responsibility and life's responsibility. To so teach boys that they may earn good wages at a trade, and at the same time neglect to give them that training which will enable them to live wisely while earning that money, is a false position for any school to take. However, I should not have social and economic work incorporated as a set course. It is rather a point to be considered as entering into all the instruction.

Tuition Fee should be Charged.

There should be a tuition fee both for the day and evening work. It is the experience of most of us, not only in school work, but in all concerns of life, that what we pay for, we value, and that what we get free is not always appreciated. Provision should be made for those applicants who cannot pay the necessary fee by some scheme of scholarship fund, provided for by those patrons of the school who are enough interested in boys to take care of them financially while in school. When the boy goes to work the loan can be returned to the scholarship fund or to the one who lends the money.

Work Must be Done in a Commercial Manner to Command Respect.

In order that the trade school shall command respect, it must do work in a commercial manner, which is another way of saying that it must do commercial work, and if it does this, it will be possible to pay wages to the boys. The boys should be paid wages after the trial period, and these wages should be increased regularly according to the ability which each boy shows. It may seem strange to propose a tuition fee and at the same time return it in the form of wages. The tuition fee is a guarantee of business earnestness of the boy, his parent, guardian, or patron. Paying boys a small wage on a rising scale is done simply because we must recognize the moral value which accrues to a young man when he finds that his advancement in his trade is appreciated. It puts a practical aspect on the school's methods, and affords immense satisfaction to the young man when he receives definite compensation for his labor through an advancing scale of wages due to increased efficiency.

There is no one who ought to be more qualified to teach these young mechanics than a competent, practical man. That there would be some difficulty in obtaining such a teacher I will acknowledge, and in itself it forms an argument for the need of trade schools when we are obliged to acknowledge that not even a few men can be found who are competent to be teachers in a trade school. A successful instructor for a school of this character must be a man of exceptional ability. He not only would be required to know his trade fully, but would have to combine with that knowledge ability as a teacher, tact and diplomacy, which perhaps would fit him for positions paying far higher salaries than would be given to the instructor of a trade school. At all events the instructors will determine the success or failure of these schools.

As the school is to be a trade school and is to teach machine trades, it must for the very sake of this aim make the work of practical character, or, in other words, must make work of a commercial character, of the sort which will take a boy into real commercial life. This involves the turning out of products which will satisfy in points of accuracy and skill the demands of the industry. It means the doing of things according to commercial processes. It means that time and material consumed must be considered. In fact the school must imitate schemes of "works management" in order that the graduate may immediately fit into the economics of shop life. Throughout all the work the students must be taught the economy of material, tool-room methods, shop kinks and cost accounts. Frequent excursions should be made to the neighboring manufacturing establishments.

Lines of Work that a Trade School Can Do.

In order that the school may best illustrate commercial methods it should make things to sell. It is understood that these things are not made merely to sell for the sake of financial return, but to illustrate completely the commercial requirements of a trade. The school can do the following lines of work.

1. The making of some regular line of machinery like a bench grinder, speed lathe, bench lathe, arbor press, etc., which will illustrate to the boys how jigs and fixtures can be used in modern manufacture when a number of machines are turned out at one time. This procedure should serve to keep the shops going at all times regardless of the other lines of order work which might be on hand.

2. The school should also take repair work for small concerns. It can buy up second-hand machinery and repair it. This sort of work gives a splendid opportunity to turn out all-round workmen. It will serve to illustrate re-babbitting, re-surfacing, making of patterns from broken parts, making of castings directly from the iron form, etc.

3. Doing order work in the making of jigs and fixtures for various manufacturing concerns. This special order work can be done by older and brighter boys who understand the reading of drawings and the laying out of the work. It will give them an opportunity to use their ingenuity in discriminating between that work on the jig which must be done very accurately and that which can be slighted without damage to the commercial efficiency of the jig. It will teach the boys how to figure on the cost of jobs, etc.

4. The making of patterns and castings for special orders of outside firms.

There is not a city of any size having machine trade industries which cannot have such a school, providing there are enough resident manufacturers who have an interest in the American boy as well as an interest in the future of American industry, and providing these manufacturers and public spirited men will put their hands down into their pockets and give the money necessary to start the school.

Can such a School be Made Self-supporting?

I suppose the school can never be completely self-supporting, although some men who think they know what they are talking about (and two of them have tried it) say that it can be made self-supporting. Personally, I think it would be well to allow considerable financial leeway. It is not necessary to wait until these interested men can gather up money enough for a fine building. All that is necessary is to lease for a term of years a building suited to the purpose. There are manufacturers of iron working machinery in the country who will be glad to contribute liberally to the equipment. It is not necessary to have a power plant in the building, and thus the cost of an expensive portion of ordinary school equipment can be saved. Purchased electric power will suffice for the first few years. I have estimated that a yearly expense of $20,000 will give instruction to 200 boys in the day school and 275 boys in the night school. This sum includes administrative and teaching force, rent, heat and light, and materials.

Certain features of this school probably prohibit it being, at its inception, a part of the public school system, but some such plan as I have presented can open the way for larger public enterprise.

* * *

A CURIOUS RESULT OF HIGH TARIFF.

A curious and amusing illustration of the effects of protection, says the *Mechanical Engineer* (London), was afforded a few days ago by a deputation of American watch dealers which waited upon the president of the Board of Trade. It appears, from their statements, that the four great watch manufacturing companies of America are banded together with a view to keep up prices. This, of course, is possible in the United States, with its tariff wall, but in the British market, where the trust has to meet Continental competition, the goods are supplied at much lower prices than those which rule in the United States. As a consequence of this, American retailers have been in the habit of purchasing their supplies of American watches in the British market at an increase of 5 per cent on the invoiced price, and then reshipping them to the United States, where, being of American manufacture, they are not liable to duty. In this way the trust finds itself undercut in its own market by its own goods; and it would appear from the statements of the deputation that the trust is making desperate efforts to prevent this undercutting. British traders are informed that they can only be supplied on condition that they undertake to forfeit £5 if they allow a watch to get into the hands of an American dealer. But it is difficult to see how such efforts can prove effective, or why American dealers should seek assistance in this country (England)!

MAKING SWISS FILES IN AMERICA.—1.*

The plant of the American Swiss File and Tool Co. of Elizabethport, N. J., was described in MACHINERY, April, 1905. In that article the processes used at the time were quite fully described and illustrated. Since then the business has grown rapidly, manufacturing methods have been improved, and a new and enlarged factory has been built. These changes have offered so much new material of interest and value that it has seemed decidedly worth while to describe the plant again, touching lightly on the points fully treated in the previous article, and going more into details on other points.

Most of the tools a machinist or tool-maker uses have nothing of great difficulty or mystery connected with their making. Any good tool-maker, if necessity demands, would feel competent to make for himself a twist drill or a micrometer caliper, even though these tools are seldom made for personal use, but are almost invariably purchased. There is a different feeling in the case of files, however. A good file is treasured by the man who owns it. He looks upon it with friendliness, and respect as well, for while he can buy files by the thousand (good, bad and indifferent) from people who make a business of making them, he would not be able to make one himself. The matter of cutting those fine teeth, so well formed and regular, and yet so delicate as to be in the finer sizes almost invisible, and afterwards the hardening of the tool to the proper degree without injuring the sharpness of these multitudes of little teeth, he feels to be beyond the range of his ability. File makers, in general, have rather catered to this idea of mystery. Their shops are surrounded by high fences and the visitor gets no further than the office. Their catalogues are full of little hints and suggestions of the complicated special machinery used, and the secret and mysterious formulas and processes followed in the annealing and hardening departments.

In the face of all this mystery, Mr. E. P. Reichhelm determined to embark in the manufacture of files, and not merely in the making of ordinary hand machinists' tools of the coarser grades, but those of finest and most delicate shapes, in which the Swiss makers had hitherto held undisputed preeminence. We have had occasion before now to refer to cases where men have resolutely embarked in work of this mysterious nature with not much more than determination and common sense, and nothing in the way of tradition and prejudice, to guide them. This is still another case in point. While it is not to be supposed that Mr. Reichhelm developed his methods of manufacture full-fledged from the start, and that there is no further improvement possible in his methods, yet he has already succeeded in building up a business which is limited in extent only by his ability to get good workmen, and he is to-day turning out a product which at least equals the best that is produced abroad.

As stated in the previous article, Mr. Reichhelm was led to undertake this business from his previous experience in the hardening and annealing of steel. He is the moving spirit of the American Gas Furnace Co. which has made a specialty of that work for many years, so his experience is a most valuable one. The one point of superiority of European hand-cut files over American machine-cut ones, is in the matter of uniformity in size and sharpness of the teeth; the advantage of the hand-cut file is not due, as many have supposed, to a quite different condition—the irregularity of the spacing. The reason why it is possible, usually, to obtain more regular shaped teeth from hand cutting, done by skilled workmen is that, until now, the best methods of annealing with the best and most uniform tool steels produced uneven results. In the machine, whenever the chisel comes to a hard spot, a shallower cut is made; when it comes to a softer spot the cut is deeper, and the tooth sharper. In cutting a file by hand, however, the workman can follow the effect of his chisel, striking it harder in the hard spots, and lighter where the metal is soft. With these conditions understood, it is evident that uniform annealing is the prime requirement for

Fig. 1. Plant of the American Swiss File and Tool Co., Elizabethport, New Jersey.

* The following articles dealing with file manufacture and machinery have previously appeared in MACHINERY: File Cutting Machine, October, 1903, engineering edition; The Making of Fine Toolmakers' Files by American Methods, April, 1905.

producing a first-class file of the high grade required by toolmakers and watch-makers. On his skill and experience along this line Mr. Reichhelm based his confidence. The present extent of the business, and the rate at which it is growing, tend to show that his confidence was not misplaced.

The Buildings.

The plant is located on an irregular tract in Elizabethport, N. J., bounded by streets on three sides. The place was specially selected on this account with the idea of having it always open to light and air. As shown in Fig. 1, the main building is two stories in height. Back of this is a one-story building, with a power plant at the eastern end. The lay-out of the departments is shown in Fig. 2. The rough stock is received at the shipping door at the front of the main building, whence it is carried through into the stock and cutting-off rooms in the one-story extension. From here the cut stock is taken to the blacksmith shop, thence to the annealing room, the grinding department, the stripping department and the blank storage, all as indicated in the cut. The teeth are formed by either of the two processes of cutting or etching, as will be described later. The cutting is done downstairs at the north end of the building, while the blanks which are to be etched are taken to the room directly above the cutting department on the second floor. After cutting, they go to the hardening room near the center of the main building, and from there are taken to the packing room directly above. It will be seen from this that there is a complete circuit with no loops or backward movements, from the receiving of the raw material to the delivery of the finished goods. All the rooms are of ample size for an equipment of three times the present capacity, so this increase can be made without disturbing the arrangement shown. Having the general plan of the works thus before us we can follow the process from step to step.

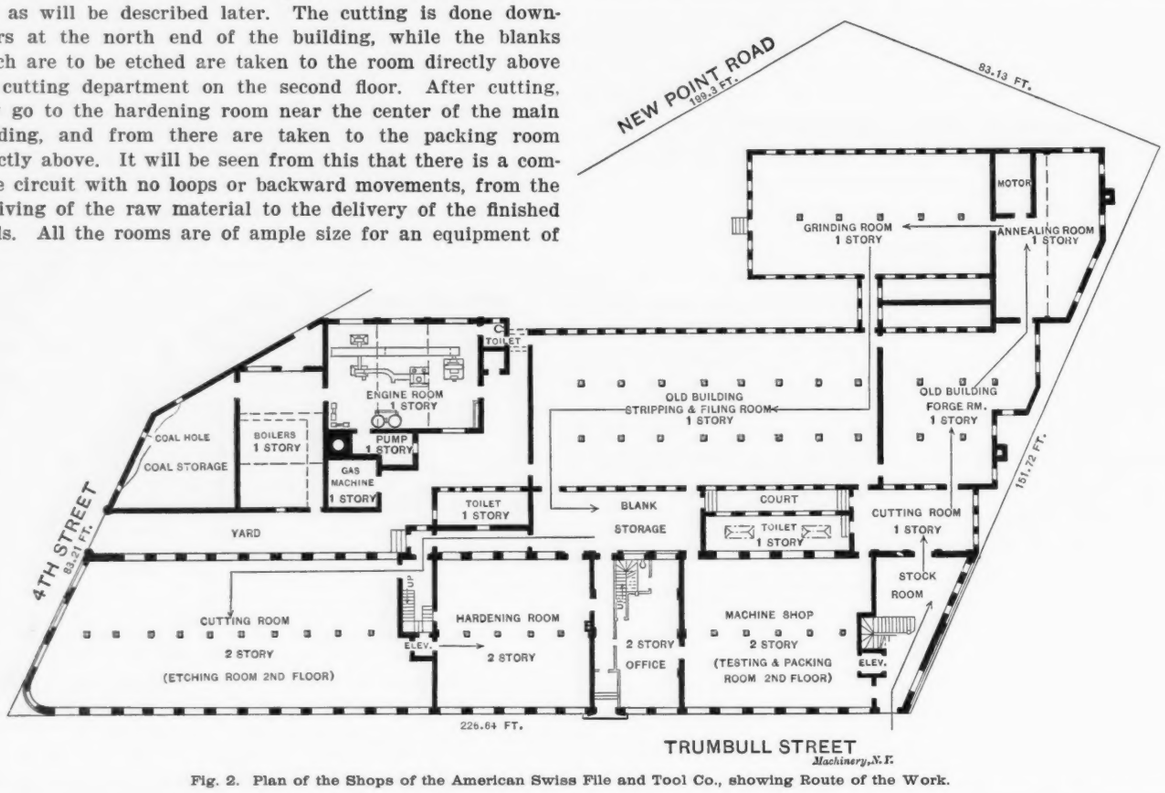


Fig. 2. Plan of the Shops of the American Swiss File and Tool Co., showing Route of the Work.

Blanking and Forging.

The raw material received comes in various forms, generally of the exact shape of the "amid-ships" section of the file. In a few cases sheet stock is used for thin flat files of various forms and uniform thickness. These are punched in blanking dies under a punch press. For half-round, round, square, barrette and other styles, stock of appropriate shape is cut in the shears to the proper length. From here it is taken to the forging department. In this room, aside from the noise which is unescapable where power hammers are used, the thing which first strikes the visitor is the clearness and comparative coolness of the air. There is none of the dust and smoke usually associated with the operation of forges. This, of course, is due to the use of gas furnaces with their smokeless, dustless fuel in the place of the coal forges ordinarily found. A furnace stands at the side of each smith, and a very small and inconspicuous affair it is. A fire-brick lining in an iron casing with four legs to stand on, with piping and burners for gas and air, is all there appears to be to the apparatus. The furnaces are quite small, being only just wide enough for the length of the files being heated. The uniformity of the temperature throughout the whole area of the furnace is remarkable, there being no difference visible to the eye in color anywhere within the heated area. The first operation is the forming of the tang. Then the blanks are reheated, and worked to the proper shape under dies. The face of each die is made in three sections. That on one side of the die is used for breaking down the stock, that on the other side for bringing the edge of the stock to approximately the right dimension, while the central section is used in forming the sides or faces of the blank. The workmen handle these with great rapidity and dexterity, changing the work quickly from one side to the other, and back again to the middle, turning and re-turning the blank until it is formed to the shape determined by the dies. It is impossible to form some shapes correctly under the power hammer. The barrette, and the point of the half round, for instance, have to be finished by drop forging. The former shape of file is struck up from a round blank. The amount of scale found around the hammers and drop presses is very small—an indication of the non-oxidizing quality of the flame in the gas furnace. Each workman has a private supply of cool air from the pressure service which he can direct on himself in whatever way best suits his convenience and comfort.

Annealing.

As stated in the beginning, Mr. Reichhelm considers that the secret of fine file making lies primarily in the matter of annealing. This is the next operation after the forging. One might expect from the importance of this part of the work to find elaborate precautions taken. One would suppose that the blanks would be packed with charcoal in cases having covers luted with fire-clay; such precautions are generally considered necessary to get even heat and freedom from oxidation. Nothing of this kind is seen in Fig. 3, which shows a general view of the annealing room. There are here, as shown, a number of gas furnaces of various sizes. The big ones are for big files, and the little ones, for little files. The blanks are packed in the furnaces, unprotected, exposed to the direct action of the flame. The precaution of packing them with the tangs outward and the points inward is taken, but otherwise the metal is not shielded in any way. The flame is lighted and kept going at a temperature of 1,500

degrees Fahrenheit, for about four hours, ordinarily; then (the doors being carefully closed) the work is allowed to remain over two nights and one day, until it is perfectly cool. There is a very slight, thin scale resulting from this heat treatment, but no pitting or corrosion. What little scale there is comes from air which leaks in during the cooling process, the flame itself being absolutely non-oxidizing. It

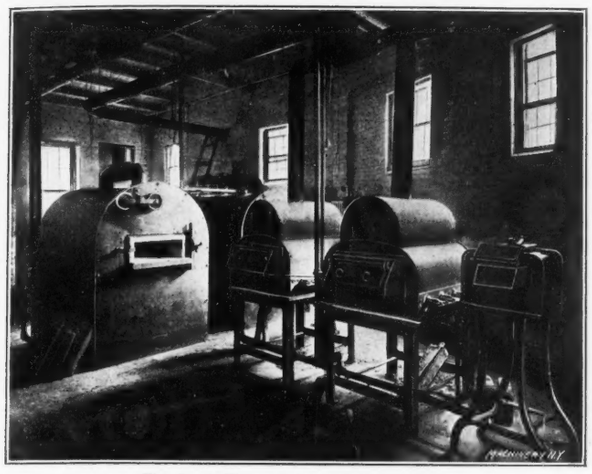


Fig. 3. A View of the Annealing Room.

would be difficult to find a better commercial test of the excellence of the fuel gas process used, than this.

The uniformity of annealing obtained is the result of the fulfillment of several simple conditions. There must be a constant quality pressure and amount of gas, and a constant pressure and volume of the air mixed with it. With these mixtures determined, the nature of the flame and the temperature will be constant. Too much cannot be said about the composition of the flame. The vaporized naphtha used is free from injurious elements, such as sulphur, and is provided

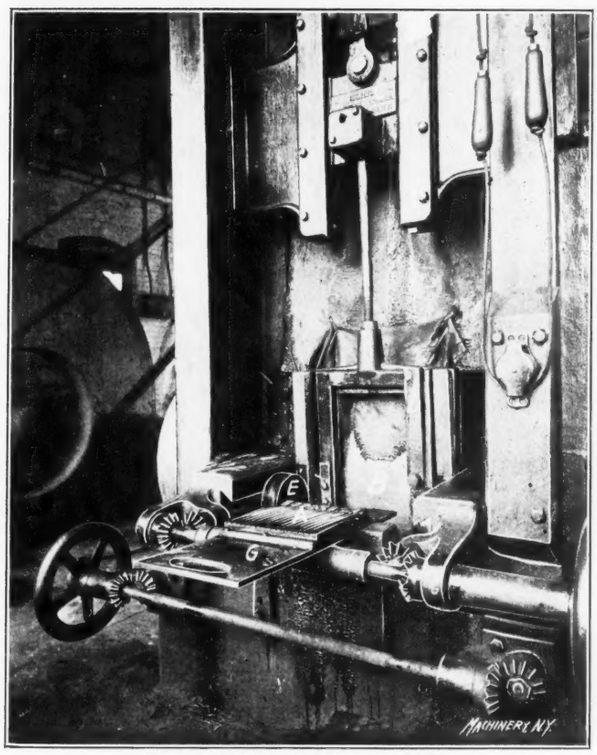


Fig. 4. Machine for Grinding Flat Files.

with a slight under supply of oxygen, so that there is no danger of any of that element combining with the metal. The furnace must be so built that the heat is evenly distributed throughout the whole of the interior. The file on the bottom of the pile must be heated under the same conditions as the one at the top. The ends and sides of the furnace must each be subject to exactly the same degree of heat. With these points carefully looked out for, and with the matter of time of exposure to the heat attended to, it only remains to provide the proper steel to be able to get the same results day in and day out, in the annealing of file blanks. For the finest work, Mr. Reichhelm has been unable, sad to say, to find an American steel which will give good results. The best that can be obtained varies in composition and resulting hardness from one bar to another, and from point to point in the same bar. The necessity for uniform hardness in the annealed blank involves in this case the necessity of patronizing a foreign firm instead of a home industry.

Grinding and Stripping.

In order to form sharp teeth of uniform height, it is necessary to provide a smooth, even surface to start with. To produce this surface the blanks are first ground and then draw filed or "stripped." The files with flat cutting surfaces have them ground on automatic machines. A near view of one of these machines is shown in Fig. 4. At *B* is a grindstone of large diameter, revolved at suitable speed and traversed slowly back and forth by a cam, to equalize the work across its face. The files, shown at *A*, are ranged in a row, with

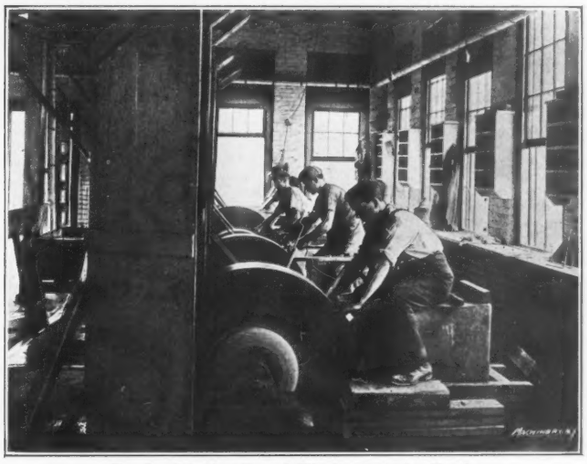


Fig. 5. Grinding Round File Surfaces by Hand.

suitable backing and supports, on the flat plate or holder *G*. This frame or holder is dropped in a vertical position in slide *D*, and pressed up against the face of the revolving grindstone *B* by the rollers *E* and the adjusting screws operating them. The mechanism which reciprocates slide *D* up and down, so that the blanks are ground from one end to the other, is then started. In the machine shown this motion is operated by an adjustable crank at the top of the machine, connected to crosshead *C*. The matter of grinding a frame full of blanks is one of a few strokes and a few seconds only. The wheels used are five or six feet in diameter, and means are provided in the machine for keeping them constantly trued.

This machine grinding is done on flat surfaces only. On round surfaces the grinding is done by hand. In Fig. 5 may be seen workmen engaged in this operation. Most of them are working on half-round files. As may be seen, they are sitting on wooden blocks in front of large grindstones, all except the man in the foreground, being astride of a board with a steel hook or holder on the end of it, which holds the work down to the wheel. The weight of the workman thus furnishes the pressure needed for grinding. The smallest and finest files, whether flat or round, are ground by hand on carefully trued wet emery wheels.

The surface produced by this grinding is not quite good enough for the purpose desired, so the finishing touches are given by draw filing or "stripping." Both flat and round surfaces are finished in this way, and all burrs are removed from edges and corners. The men work at benches, with the blanks supported by their ends in wooden blocks. For stripping flat surfaces, a new machine has recently been introduced. One of these is shown in Fig. 6. The blanks, *B*, are held in suitable holders. These holders are pressed upward

by levers and weights against the cutting files *E* in slide *D*. This slide is moved in and out for the stroke, being carried by saddle *G*, which slides along ways on the under side of overhanging arms *H H*. It is also traversed back and forth to distribute the action over the full length of the cutting files by a drunken screw at *F*. The work is relieved from contact with the files on the back stroke. It might be expected that it would be a matter of some difficulty to avoid "pinning" in a case of this sort. This is not often met with, however. In the first place the files are made specially for the purpose, with plenty of clearance. Besides this, the pressure on the work is unvariable, being determined by the weights and levers mentioned. A workman, even though expert, might momentarily use more pressure than he ought to on his file, so as to cause it to tear the steel and get the broken particles wedged or "pinned" in the teeth. With a machine, having once found the conditions necessary to avoid this trouble, these conditions may be preserved indefinitely, and the trouble practically avoided. When it does occur, perhaps once a day, the blank thus injured has to be reground and refiled.

Flat files are ground and stripped on all of their cutting surfaces before going to the cutting department. On files having sharp edges, however, such as half-round, barrette, and other shapes, this course is not followed. On a half-round file,

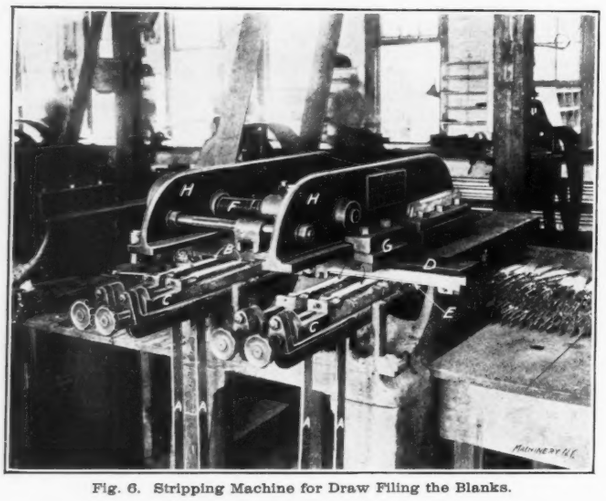


Fig. 6. Stripping Machine for Draw Filing the Blanks.

for instance, the flat surface is stripped; then the first cut is taken over it, and it is returned to the stripping room to have the round surface finished, which then, in turn, is treated with the first cutting; after this the second cut is given to the flat side, and then to the round side. This working first on one side and then on the other, on a blank having sharp edges, is necessary to keep the teeth perfect in shape clear out to the edge. If one side were finished completely before the other was touched, the edges would be turned over, away from the surface last finished, making a sharp burr on the side which was cut first.

After the blanks have been stripped, they are taken to the blank storage, awaiting their turn at the cutting machines. The cutting of the teeth and the hardening of the file will be described in a succeeding installment of this article.

* * *

USING A CANNON FOR DISSOCIATING A SHRINK FIT.

A contributor to the *National Engineer* of May, 1907, describes a device which is well known and much used in railroad shops. Machinists in other lines, however, are probably not so familiar with it. This device is a cannon which is used as a sort of desperate remedy, when everything else has failed, for knocking out crank-pins, axles, and other shrunk and rusted joints. It is somewhat dangerous to use, so should not be ordinarily employed.

The writer referred to says in substance: "On a recent visit to the plant of the Kittaning Iron & Steel Co., I witnessed a novel method for removing broken crank-pins from crank disks. A crank-pin 8 inches in diameter had broken off close to the crank disk, and several men had spent considerable time in a futile effort to drive out the remaining part of the broken pin. Finally the chief engineer ordered one of the men to bring in the cannon. It was made, as shown in Fig. 1, of a piece of steel with a 2-inch hole bored in it longitudinally. A ¼-inch hole for the fuse and a 2-inch hole for the escape of the gases of combustion after they had completed their work, were drilled in from the sides as shown, to meet the center hole of the device.

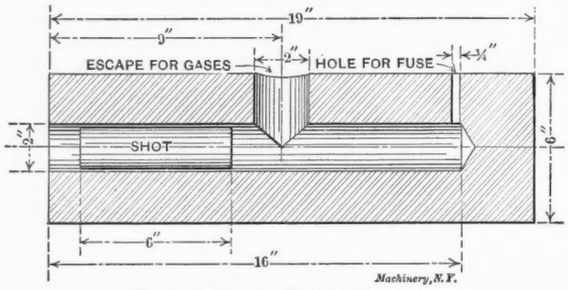


Fig. 1. Cannon for Machine Shop Use.

"The cannon was loaded with about ½ pound of giant powder. A piece of 2-inch case-hardened steel called the 'shot' was inserted in the opening, and all was firmly chained to the disk, as shown in Fig. 2, with the opening of the cannon directly over the crank-pin. A fuse was inserted in the small opening, and ignited. All hands then sought places of safety. A heavy explosion soon followed, after which an examination showed that the pin was still intact in the disk, notwithstanding that the shot had embedded itself in the pin ¼ inch. The cannon was again loaded, fastened in position, and fired, which loosened the pin so that a few blows from a heavy hammer drove it out of the disk.

"When the cannon was fired, the smoke and flame caused by the explosion followed the shot until the latter passed the 2-inch opening on top, through which they escaped to the atmosphere.

"The engineer informed the writer that the cannon had been in use over a year, and that during that time it had been used over sixty times for removing keys, pins, etc., without an accident, except on one occasion. On this occasion the fuse hole was by mistake turned toward a window, and the resulting concussion destroyed the glass and sash of the latter.

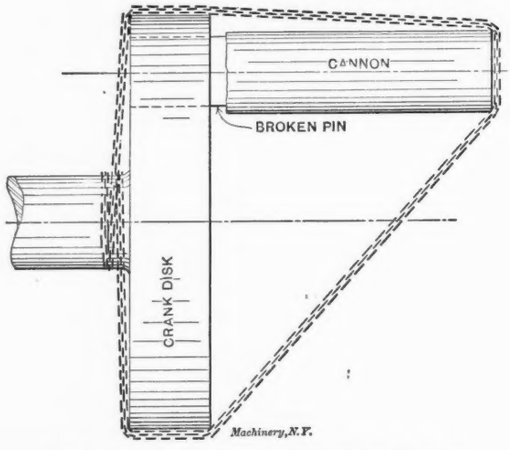


Fig. 2. Cannon Charged and Aimed, ready for Firing.

When the shot was first made, it was only hardened for about two inches of its length. The result was that the impact of its striking the object to be removed, enlarged its diameter so that it stuck in the bore of the cannon and had to be bored out."

* * *

One of the causes of a serious loss in the transmission of compressed air is pumping the air of the engine room rather than air drawn from a cooler place. This loss amounts to from 2 to 10 per cent.

METHODS OF DELICATE TURNING.

There are some kinds of work that do not come up in the ordinary run of business, but which are met with occasionally, and are liable to give considerable concern when they do appear. It is not often, for instance, that one has to turn a 3/16 inch steel rod 26 inches long down to a diameter of 1/16 of an inch. This delicate operation may be performed easily when called for, if it is gone about in the right way. *Engineering*, of London, in the June 7, 1907 issue, contains a description of the way in which an Englishman, Mr. Henry Lea, of Birmingham, performed this operation. The stock, which is of mild steel 3/16 inch diameter as stated, was placed in a 5½-inch (11-inch swing) lathe, one end being caught in a chuck on the spindle, and the other supported by the tail-

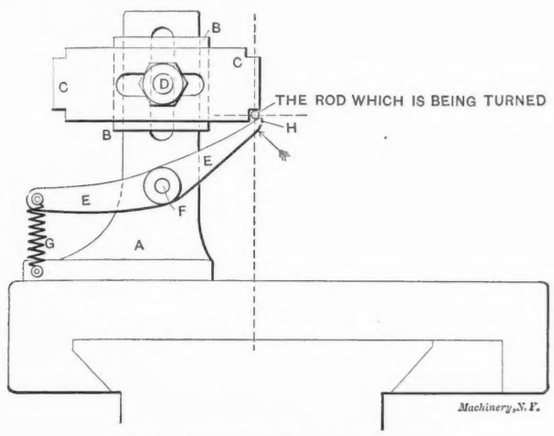


Fig. 1. Follow-rest for Delicate Turning.

center. It is necessary of course to use a follow-rest to do turning of any kind with such slender work. The follow-rest used is shown in Fig. 1. It is composed of a bracket *A* fastened to the rear of the carriage. This bracket carries a vertical slider *B*, which again carries a horizontal slider or steady plate *C*, which is hardened and has notches in the four corners, of sizes to suit rods of different diameters. The bolt *D* locks plates *B* and *C* to the bracket. *E* is an arm pivoted at *F*, and provided with a coiled spring *G*, the effect of which is to press the nose *H* against the under side of the revolving rod in a slightly inclined direction, as shown by the arrow, thus keeping the revolving rod in contact with the two sides of the notch in plate *C*.

A portion of the rod next the chuck was turned true, and the steady was adjusted to it. The turning tool (Fig. 2) is a very keen side-tool, facing away from the chuck, and its cutting edge was normal to the axis of the rod, so that the

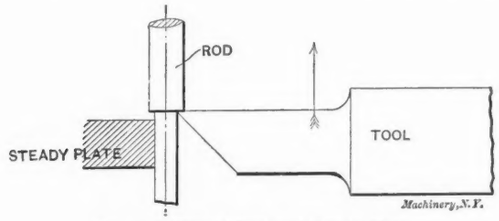


Fig. 2. Setting of Tool and Steady Plate.

tool had no tendency either to force the rod inwards or to draw it outwards. The point of the tool was set about 0.02 inch in advance of the steady plate. The speed and feed were about 250 revolutions per minute and 180 turns per inch of travel. Oil was kept dropping on the point of the tool. The first few cuts were about 0.002 inch deep; the final cuts were 0.0005 inch each.

It is most important in work of this kind that the cut should be taken in a direction away from the chuck, and that the pressure of the tail-center be so light as not to bend the rod by end compression. As the work proceeds, the rod becomes so slender that the steadying effect of the tail-center is practically nil, and two loose wooden supports standing on the lathe-bed were used instead, having V-notches for the rod to revolve in. As the saddle receded from the chuck, one, and then both, of the supports were transferred to the left-hand side of the saddle, so as to support the portion already turned. The time required for each cut was 12½ minutes. The first one or two cuts removing the skin left the rod rather crooked, but it became more and more straight after each succeeding cut, and the last cut left it practically straight.

There is another delicate lathe operation of a different kind which is well known to clock and watch tool-makers, though perhaps not to machinists engaged in heavier work. Supposing it were required to finish complete from the bar in one chucking a small pinion blank, such as shown in Fig. 3. It is apparent, after looking the piece over, that the only difficulty in making it thus, lies in getting a sharp point where the bearings are, on each end of the piece. It will at once be seen that the end next to the solid bar from which the piece is formed will break off, under the pressure of the cut used in forming and separating this end, a considerable time before the tool point has reached the center, thus leaving a blunt, ragged pivot where a sharp, smoothly finished one is desired.

The way in which this operation is performed is shown in Figs. 4 and 5. The work is cut off, and the point shaped in such a way that the entire pressure of the cut comes on the bar of stock held in the chuck, and none of it on the work. The outer end of the work is held in a supporting bushing in the lathe or screw machine in which the work is being done. A tool of the shape shown is used for severing the work from

Fig. 3

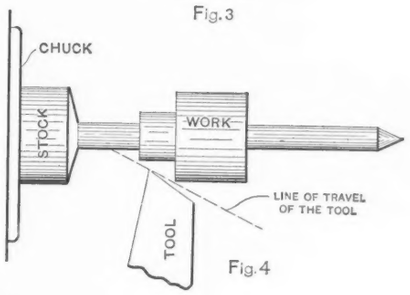


Fig. 4

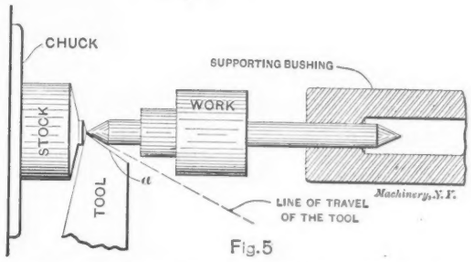


Fig. 5

Figs. 3, 4 and 5. Finishing a Pivot at the End where it is Cut from the Bar.

the bar. This tool, it will be noticed, is not fed straight in, but is moved in on an angle that will form the pivot to the right shape. Face *a* is beveled so that it clears the work entirely. The point is quite sharp. The cutting action is thus entirely on the face of the stock, and the work is not subject to any pressure whatsoever. Being supported by the bushing in the rear, even the weight of the piece has no tendency to sever it before it is cut away by the tool, and when it is finally separated it is still supported in the same position as before the separation took place. This method of doing the work saves the separate operation which would otherwise be necessary for pointing the pivot at the end where it was severed from the bar.

* * *

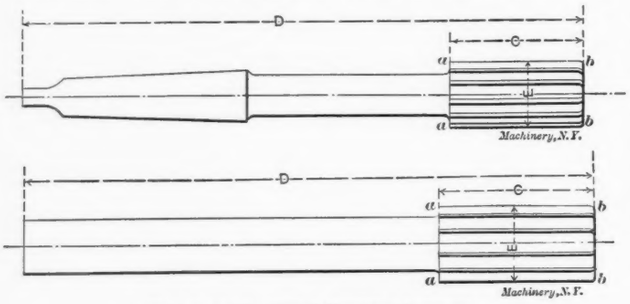
The *Brass World* calls attention to the fact that too much phosphorus in a phosphor-bronze bearing causes the tin to liquidate in the form of "tin-spots," which are nearly as hard as steel. Such "tin-spots" cut the axle and cause the bearing to heat.

REAMERS.—2.

ERIK OBERG.

Fluted Chucking Reamers.

Fluted chucking reamers are used in machines for enlarging holes as well as for finishing them smooth and true to size. These reamers are usually provided with either straight or standard taper shanks, as shown in Figs. 6 and 7. They are not intended for removing a large amount of stock, 0.005 to 0.010 inch being all that should be required. The cutting edges are along the lines *a b*. At the front end of the reamer there is a slight round as shown at *b*. It is a well known occurrence that reamers held rigidly at the end of the shank are liable to cut holes somewhat larger in diameter than their own size. In cases where a very accurate hole is desired, reamers used for chucking purposes should therefore be somewhat smaller than the final size of the hole to be reamed, be



Figs. 6 and 7. Fluted Chucking Reamers.

held in a floating reamer holder, and after having reamed the hole by a chucking reamer, it should be finished by a hand reamer.

Number of Flutes.

The number of flutes with which fluted chucking reamers should be provided is given in Table IV. It will be noticed that the pitch of the cutting edges, or the distance from cutting edge to cutting edge, is in some cases a trifle smaller than in the case of hand reamers. The same fluting cutters as are used for hand reamers are used for fluted chucking reamers also. The radii of the small rounded corners at the end

TABLE IV. NUMBER OF FLUTES IN FLUTED CHUCKING REAMERS.

Size of Reamer.	Number of Flutes.	Size of Reamer.	Number of Flutes.	Size of Reamer.	Number of Flutes.
$\frac{1}{8}$	6	$\frac{7}{8}$	8	$1\frac{3}{4}$	12
$\frac{1}{4}$	6	1	8	2	12
$\frac{5}{8}$	6	$1\frac{1}{8}$	10	$2\frac{1}{4}$	14
$\frac{1}{2}$	6	$1\frac{1}{4}$	10	$2\frac{1}{2}$	14
$\frac{5}{8}$	8	$1\frac{3}{8}$	10	$2\frac{3}{4}$	16
$\frac{3}{4}$	8	$1\frac{1}{2}$	10	3	16

TABLE V. NUMBER OF MORSE TAPER SHANKS FOR FLUTED CHUCKING REAMERS.

No. of Morse Taper Shank.	Sizes of Reamers, inches.	No. of Morse Taper Shank.	Sizes of Reamers, inches.
1	$\frac{1}{8}-\frac{1}{2}$	4	$1\frac{9}{16}-1\frac{3}{4}$
2	$\frac{17}{32}-\frac{7}{8}$	5	$1\frac{25}{32}-3$
3	$\frac{29}{32}-1\frac{1}{4}$	..	.....

of the flutes at *b*, Figs. 6 and 7, should be 1/32 inch for sizes up to and including ¾ inch diameter, and 1/16 inch for larger sizes.

Dimensions of Fluted Chucking Reamers.

The principal dimensions of consequence are the over-all length and the length of the cutting portion of the reamer, denoted *C* and *D*, respectively, in Figs. 6 and 7. The over-all length of the straight shank and the tapered shank chucking reamer are usually made the same. The Morse standard taper shank is nearly always used on this class of reamer. The sizes of reamers and the corresponding Morse taper shanks with which they are provided are given in Table V.

The length of the cutting edges *C* and the total length *D* may be determined from the formulas

$$C = E + \tfrac{3}{4} \text{ inch, and}$$
$$D = 4E + 4 \text{ inches,}$$

in which formulas *E* denotes the diameter of the reamer. Dimensions figured from these formulas are given in Table VI.

The diameter of the neck between the fluted part of the reamer and the taper shank, Fig. 7, should be about 1/32 inch smaller than either the diameter of the reamer, or the diameter at the large end of the shank, depending upon which of these two diameters is the smaller, so that the grinding wheel will clear the necked portion both when the reamer part and the shank part are ground.

The diameter of the straight shank should be from 1/16 to ¼ inch below the size of the reamer for sizes up to 1½ inch diameter. For larger sizes the shank may be proportionally smaller, so that the shank for a 2-inch reamer is 1½ inch, and for a 3-inch reamer, 1¾ inch.

Rose Chucking Reamers.

The rose chucking reamer is not intended for finishing holes smoothly or true to size, but is merely used for enlarging cored holes, and is so constructed as to enable the removal of a considerable amount of stock. As shown in Fig. 8, the cutting edges are beveled to a 45-degree angle at the end of the reamer. The teeth are cut on the end only, so as to give a cutting edge to this 45-degree bevel. At every other cutting tooth there is a groove cut the full length of the reamer body. This groove serves the purpose of providing a way for the chips to escape, and forms a channel for lubricants to reach the cutting edges. The groove, however, does not provide for any cutting edge on the cylindrical part of the reamer.

Formerly rose reamers were often made without these

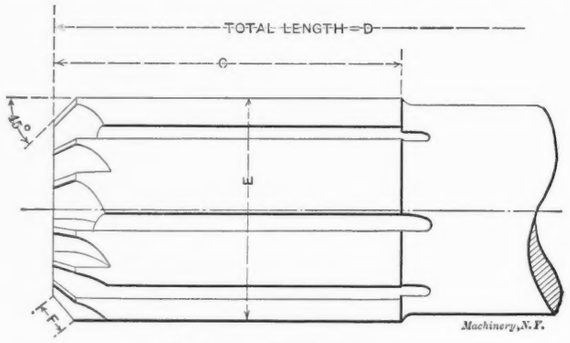


Fig. 8. Rose Chucking Reamer.

grooves; the body of the reamer was solid with the exception of the cuts made to form the teeth at the end, but this construction caused a great deal of trouble on account of the reamer binding in the hole to be reamed. The binding effect is overcome by cutting the grooves for every other tooth, as mentioned. In fact, there is no reason why this groove should not be cut for every tooth, excepting that it would increase the cost of making the tool, and not being imperative, this cost is, of course, properly avoided.

Rose chucking reamers are slightly back tapered on the cylindrical body, that is, the diameter at the point with the beveled cutting edges is slightly larger than the body where it joins the shank. This provision also aids to prevent the tool from binding, in the hole being reamed. The back taper ought properly not to exceed 0.0005 inch per one inch, although it is usual in the manufacture of these reamers to make this taper as much as 0.001 inch per inch.

The length of the beveled edge *F*, Fig. 8, should increase with the diameter of the reamer. The length of this bevel for different sizes of reamers is given in Table VII.

The rose chucking reamer will produce holes slightly larger in diameter than the actual size of the reamer, and for this reason this tool should always be made from 0.005 to 0.010 inch smaller in diameter than the finished size, and should be followed, when in use, by a fluted reamer for finishing. For enlarging cored holes, however, these reamers are of great advantage, firstly, because they are able to take a heavy cut, and secondly because they will cut a hole that is more nearly parallel or straight than will a fluted reamer, particularly if there are blow-holes or hard spots in the walls of the surface being worked upon.

Fluting Rose Reamers.

The grooves with which rose reamers are provided along their cylindrical surface, not being intended to produce cutting edges, are not of the same shape as those cut in fluted reamers. A convex cutter, having a width equal to from one-fifth to one-fourth the diameter of the rose reamer itself, should be used for cutting the groove. The depth of the groove should be from one-eighth to one-sixth the diameter of the reamer. The cylindrical part of the reamer between

TABLE VI. DIMENSIONS OF FLUTED CHUCKING REAMERS.

Diameter of Reamer.	Length of Flute.	Total Length.	Diameter of Reamer.	Length of Flute.	Total Length.
E	C	D	E	C	D
1/4	1	6	1 1/8	2 1/8	10 1/2
5/16	1 1/16	6 1/4	1 1/4	2 1/4	11
3/8	1 1/8	6 1/2	1 5/8	2 3/8	11 1/2
7/16	1 3/16	6 3/4	1 3/8	2 1/2	12
1/2	1 1/4	7	1 7/8	2 5/8	12 1/2
9/16	1 5/16	7 1/4	2	2 3/4	13
5/8	1 3/8	7 1/2	2 1/8	2 7/8	13 1/2
11/16	1 7/16	7 3/4	2 1/4	3	14
3/4	1 1/2	8	2 3/8	3 1/8	14 1/2
7/8	1 5/8	8 1/2	2 1/2	3 1/4	15
1	1 3/4	9	2 3/4	3 1/2	16
1 1/8	1 7/8	9 1/2	3	3 3/4	17
1 1/4	2	10	..	..	..

the grooves should not be relieved, but should be left circular.

Rose reamers smaller than ¼ inch in diameter may be made without grooves, but in such a case they should have only three teeth on the end, and fairly deep cuts between the teeth to take care of the chips. The best practice is, however, to provide rose reamers of all sizes with grooves on the cylindrical part.

The number of cutting edges on the 45-degree beveled end of the reamer are made according to the figures given in Table VIII. The number of grooves is evidently equal to half tne number of cutting edges, there being one groove on the cylindrical part for every second cut at the end. The cuts at the end are milled with a 75-degree angular cutter. The width of the land at the cutting edge should be about one-

TABLE VII. LENGTH OF BEVELED CUTTING EDGE OF ROSE CHUCKING REAMERS.

Size of Reamer.	Length of Beveled Cutting Edge.	Size of Reamer.	Length of Beveled Cutting Edge.	Size of Reamer.	Length of Beveled Cutting Edge.
1/4	1/32	7/8	1/16	2	1/8
5/16	1/32	1	5/64	2 1/4	5/32
3/8	1/32	1 1/8	5/64	2 1/2	3/16
7/16	3/64	1 1/4	3/32	2 3/4	3/16
1/2	3/64	1 3/8	3/32	3	7/32
9/16	3/64	1 1/2	7/64	3 1/4	1/4
5/8	1/16	1 5/8	7/64	3 1/2	1/4
11/16	1/16	1 3/4	1/8	3 3/4	5/16
3/4	1/16	1 7/8	1/8	4	5/16

TABLE VIII. NUMBER OF CUTTING EDGES ON BEVELED END OF ROSE CHUCKING REAMERS.

Size of Reamer.	No. of Cutting Edges.	Size of Reamer.	No. of Cutting Edges	Size of Reamer.	No. of Cutting Edges.
1/8	6	7/8	8	1 3/4	12
1/4	6	1	8	2	12
3/8	6	1 1/8	10	2 1/4	14
1/2	6	1 1/4	10	2 1/2	14
5/8	8	1 3/8	10	2 3/4	16
3/4	8	1 1/2	10	3	16

fifth the distance from tooth to tooth. If an angular cutter is preferred, rather than a convex, for cutting the grooves on the cylindrical surface, because of the higher cutting speed permissible when milling the grooves, an 80-degree angular cutter, with a slight round at the point, may be used.

Dimensions.

Rose chucking reamers are, like fluted chucking reamers, made with both straight and taper shanks. The same dimensions for the total length as were given for the fluted reamers apply to the rose reamers also, but the length of the grooved portion of the reamer, or the body, is longer. If E is the diameter of the reamer, and C the length of the grooved part (see Fig. 8), then

$$C = \frac{3E}{2} + 1\tfrac{1}{8} \text{ inch.}$$

In Table IX are given the dimensions for rose chucking reamers in accordance with this formula. What was said in regard to the straight and taper shank of these reamers, and the diameter of the neck in the latter class, in connection with fluted chucking reamers, applies to rose reamers also.

Principles of Grinding Reamers.

When grinding reamers, whether they be given an eccentric or flat relief, it is necessary to rest the face of the tooth being ground against a guide finger which can be adjusted to give

TABLE IX. DIMENSIONS OF ROSE CHUCKING REAMERS.

Diameter of Reamer.	Length of Body.	Diameter of Reamer.	Length of Body.	Diameter of Reamer.	Length of Body.
E	C	E	C	E	C
1/4	1 1/2	7/8	2 7/16	2	4 1/8
5/16	1 5/8	1	2 5/8	2 1/4	4 5/16
3/8	1 11/16	1 1/8	2 13/16	2 1/2	4 1/2
7/16	1 3/4	1 1/4	3	2 3/4	4 11/16
1/2	1 7/8	1 3/8	3 3/16	2 1/2	4 7/8
9/16	2	1 1/2	3 3/8	2 5/8	5 1/16
5/8	2 1/16	1 5/8	3 9/16	2 3/4	5 1/4
11/16	2 1/8	1 3/4	3 3/4	2 7/8	5 7/16
3/4	2 1/4	1 7/8	3 15/16	3	5 5/8

any desired amount of clearance. Fig. 9 shows an end view of a reamer being ground. A represents the emery wheel, which should run in the direction of the arrow, so that the tooth of the reamer may be pressed down on the finger B. If the wheel were running in the opposite direction, it would have a tendency to pull the tooth of the reamer away from the guide finger; the cutting edge of the tooth would then be ground away, and the reamer would be spoiled. It is claimed that when using a dry grinder, that is, one where water is not used on the emery wheel, the danger of heating the tooth and drawing the temper is greater when the wheel is run in the direction shown in Fig. 9; but if the face of the wheel is kept free from glaze, and ordinary care is exercised, there is little danger of drawing the temper, provided a cutting wheel that is not too fine is used. In order to give the tooth the proper clearance, the guide finger is adjusted to bring the cutting edge below the center line. It should not

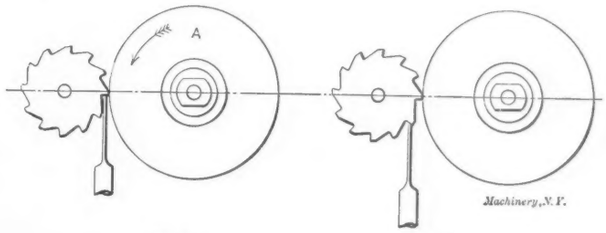


Fig. 9. Fig. 10.

be attempted to remove too great an amount of stock at one cut; it is better to take a number of successive cuts, going around the reamer several times.

When grinding reamers it is absolutely necessary to rest the face of the tooth being ground on the guide finger, otherwise the teeth, particularly when irregularly spaced, would not be ground with an equal amount of clearance, nor would all the cutting edges be at an equal distance from the center line of the reamer, and some of the teeth, consequently, would not cut when such reamers were used. Figs. 9 and 10 show, respectively, the correct and incorrect way of applying the guide finger, it being, in Fig. 10 applied to the tooth nearest below the cutting edge being ground.

Care should be taken not to give the cutting edge of a reamer any more clearance than is necessary to permit it to cut freely. Too much clearance produces a weak edge which is liable to chatter, and the reamer soon loses its size.

CREAM SEPARATOR BOWL BALANCING.*

YANKEE.

The balancing of cream separator bowls is the art of poising the rotating part or bowl so that it will run to full speed or beyond without producing any perceptible vibration in any part of the machine at any period of acceleration or falling off of speed. It is usually done by means of weights soldered in place on the bowl, or on the skimming device, and suitably distributed. A perfectly balanced bowl is one that answers the above definition, but practically slight vibrations are expected, and whatever the balancer is unable to overcome, is taken care of by using a spring bearing directly underneath the bowl. One design of this bearing is shown at the right, upper part of Fig. 1. In this design the springs are three in number and are placed in holes drilled in *G*. The proper pressure is applied by screws *H*.

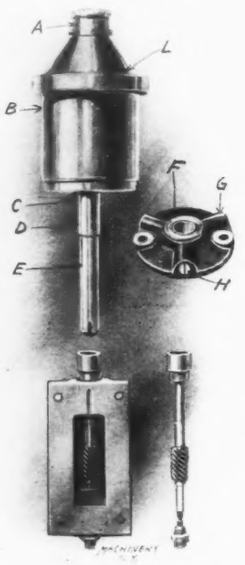


Fig. 1. Cream Separator Bowl and Stem or Spindle.

The balancing is done as follows. After mounting the bowl in a suitable frame, it is brought up to full speed, preferably by a rope drive, thereby avoiding the vibrations that result from the use of leather belting or gears. A soft blue pencil is held in a horizontal position and the bowl is marked at point *B*, Fig. 1. The spindle is marked at *D*, both over and under the spring bearing; it is also marked again at *E*.

The blue lines will show on the bowl on the lighter side and on the spindle at points *D* and *E* on the heavy side. The lines on the spindle at *D* and *E* should be directly in line with each other. When otherwise, it is a sure indication that the machinist did a poor job on this part. Imperfect spindles must be corrected before proceeding further.

Fig. 2 represents the top view of the spindle and bowl shell. We will now suppose that a line extends from 1 to 13 on the bowl shell at point *B*, and from 3 to 7 on the spindle at the points *D* and *E*. Draw a vertical line on the bowl shell directly above the center of the lines on the spindle. This is done merely to make it easier for the balancer to locate the proper place for the weight. After locating the point at about 16, melt in the bowl head on the same side, at about the point *L*, an amount of solder that is thought sufficient to bring the bowl shell up. This amount is arrived at by the cut-and-try method, and can only be guessed at by the balancer who judges the amount required by the noise of the bowl when running and the length of the line obtained. The size of the balancing weights required may range from a pinhead to that of a marble.

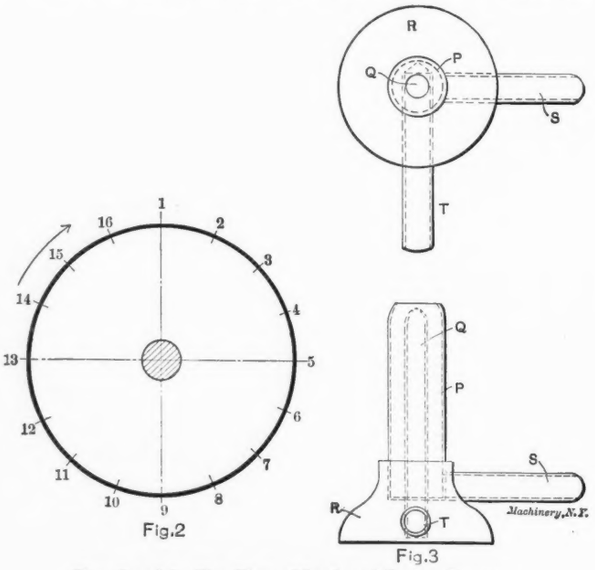
On the spindle we locate a point opposite, about 1 or 2 inches in advance or to the left of the line marked on the bowl above the center of the line on the spindle, which in this case would come at about 16. The bowl revolves, of course, in the direction of the arrow. The necessary amount of solder for this case is melted inside the bowl where it makes a joint with the bottom. All this work should be done neatly so that it is not readily noticeable by the purchaser, and also to facilitate cleaning.

Another case of a defective balance met with is as follows: Sometimes the blue-pencil lines on the bowl are directly above the lines on the spindle. In this case we put the weight in the top only and above the center of the lines. If the spindle should run very "rough" we work as described in the first case. A bowl very nearly balanced will finish up nicely and easily when showing such marks.

Still another case may be the condition in which we find the spindle when the top is not out very much, or the right end of the lines on the spindle falls under the left end of the bowl lines. All that is required in a case of this kind, usually, is to throw the weight in the bottom of the bowl slightly to the right, being governed by the amount the bowl is out of balance.

The reason that a bowl shows marks on the light side is that the axis of gyration lies between the axis of the bowl and the heavy side. This, then, makes the light side eccentric and causes it to describe a circle of a longer radius than the heavy side, hence it touches the pencil point first. The bowl being above the spindle is in a measure free to move as the forces direct, but being confined in the bearings the condition is exactly opposite. To insure perfect alignment between the bowl and spindle, revolve the bowl slightly and mark a line on same at point *B*. If this line does not extend entirely around the bowl, or should the bowl, as is many times the case, be more or less oval in shape, and the broken lines are not directly opposite, place a calking chisel in the fillet between the bowl and spindle and directly under the center of the lines on the bowl. Give the chisel a blow with the hammer according to the degree that the bowl is out. The chisel should be ground the same as the radius of the fillet, so as not to mar the spindle more than necessary. Repeat the operation, if required, until the alignment is perfect, as this condition is very important. Unless the alignment is perfect the bowl will shake badly when running up to speed.

A Bunsen burner for melting in the solder can be made as follows: Referring to Fig. 3, *R* represents a base, about 2 inches diameter. The air inlet *T* is about ⅜ inch diameter, and the gas inlet *S* is of the same diameter. The tubes *Q*, about ¼ inch diameter, and *P*, about ⅝ inch inside diameter, are connected as follows: *Q* is connected with *T*, and *P* with *S*. Tube *P* is drawn in slightly at the top so as to throw the gas toward the center. Tube *Q* is drawn in at the top until the outlet is about the size of a common pin. The top of this tube must not extend above the top of *P*.



Figs. 2 and 3. Plan View of Bowl, and Bunsen Burner.

A soldering fluid which is stainless and which enables the bowl balancer to make the soldered weights flow nicely should be used. In case it is desired to place the weights in the bowl without soldering, melt about 4 ounces of resin and pour in about three teaspoonfuls of red oil. After cooling, this composition will never harden. It is superior to putty.

The above-mentioned cases are not all of the conditions that a separator bowl balancer has to meet, but they are sufficient for a beginner to contend with, and it is practically certain that if he learns to handle these cases well, he can become a first-class balancer.

* The following articles on balancing have previously appeared in MACHINERY: Wool Cleaning Machinery, August, 1899; Notes on Balancing High Speed Machinery, December, 1904, Engineering Edition. See also the De Laval Steam Turbine and its Manufacture, November, 1904.

LAYING OUT A PROPELLER.*

J. S. WATTS.†

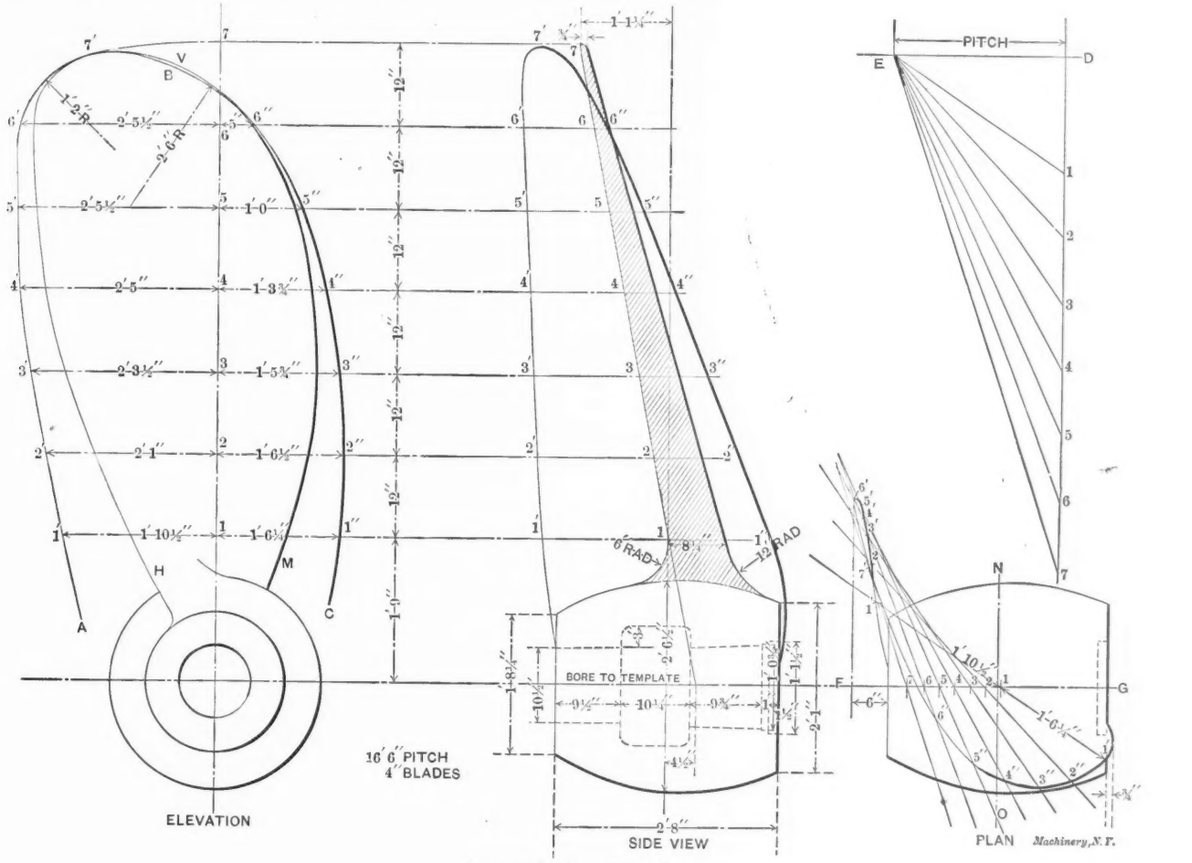
The making of a working drawing of a propeller is a problem that seems to be neglected by all technical works which the writer has had access to, and there are very few draftsmen who can successfully cope with it. The following method, while only one of the many ways in which it can be solved, may therefore be useful and interesting to many.

Formulas for finding the diameter, pitch, and surfaces required for any given horse-power and model of ship can be found in most books on marine engineering, and we will assume these dimensions of the propeller to have been fixed. The propeller shown in the cut is 15 feet 6 inches diameter, 16 feet 6 inches pitch, and 86 square feet developed surface of blades. The pitch is, of course, the amount the blade would advance in one revolution if it were made continuous around the shaft, similar to the thread of a screw. The surface is the total surface of the four blades flattened out or developed as shown in the elevation by the line *A B C*.

is not a matter of vital importance, so long as the pitch, diameter and area are correct.

We will assume that the development of the blade, as shown by the line *A B C* in the elevation, fills all the requirements, and we are to proceed to lay out the true elevation, side view, and plan view of the blade. First, on the development of the blade fill in dimensions at every 12 inches by scaling the drawing. Then draw out the blade in section, showing the droop which it is desired to have. This dimension is, like the shape of blade, a matter of controversy, varying from about 1½ inch per foot of diameter aft to about the same amount forward. The plan view of the blade can now be drawn; lay off the boss, and mark, on the center line of the boss, the positions of the center line of the blade at each 12-inch line as at 7, 6, 5, etc., taking the distance from center line of boss from the side view.

Now we must find the angles at which the blade must stand to the vertical center line to give the required pitch. To arrive at this we lay off a vertical line *D*-7 equal in length to the circumference of the circle on which point 7 is located



Layout of a Large Propeller.

We will start by drawing in the boss in the elevation. The proportions can be found in any marine engineering book. Then draw an arc of a circle equal to the diameter of the propeller. Now we can sketch in by free hand the blade laid out flat on the sheet, or, in other words, a development of the blade to about what we think will give us the right area, that is, in a four-bladed propeller one-fourth of the total surface required. Then, by trial with a planimeter, and adding to or cutting off as required, we finally arrive at the correct area and shape of blade, keeping in mind that this is not a true view of the blade as seen in elevation, but is a development of the blade. The shape of the blade is largely a matter of experience and varies for different models of boats. Every designer, in fact, has his own peculiar shape, and the variety of the forms of blades on equally efficient propellers would seem to show that, within certain limits, it

in the elevation, and a horizontal line equal to the pitch, making this figure to any convenient scale as shown. From point *D* measure off points 1, 2, 3, etc., equal to the circumferences of the circles which these numbers represent on the elevation, that is, in this case, the circumference of a 42-inch diameter circle to be the distance from *D* to 1, of a 66-inch circle to point 2, and so on. Now join these points to the other end of the line representing the pitch, and we have the angles of the blade at each of the seven points. This will be evident, if one remembers that the figure just made is a development of the thread of which the blade is a part, or, in other words, that while the propeller makes one revolution, that is, travels through one circumference (which at point 1 equals the distance from *D* to 1; at point 2, equals distance from *D* to 2, etc.), the points 1, 2, 3, etc., on the blade advance an amount equal to the pitch. This figure is generally drawn on the plan view to save trouble in transposing the angles from one view to another, but it shows the idea clearer to have the views separated in this way.

Now draw a line parallel to *E*-7 through point 7 in plan

* The following articles dealing with the design and making of propellers have previously appeared in MACHINERY: A Screw Propeller Planing Machine, October, 1903; Bauer Propeller Blade Shaping Machine, November, 1903.

† Superintendent of I. Matheson & Co., Ltd., New Glasgow, Nova Scotia.

view, one parallel to *E*-6 through point 6, and so on for all the points. On these lines mark off the distances shown in the elevation for the respective points, as on line 1 lay off 1 to 1′ equals 1 foot 10½ inches, and 1 to 1″ equals 1 foot 6¼ inches; then draw a curve through all these points, which curve is a plan view of the edge of the blade. We can now find the projection of the blade in elevation by measuring the perpendicular of each point 1′, 2′, 3′, etc., and 1″, 2″, 3″, etc., from the center line *F G*, and transferring them to the elevation. Then, by drawing a curve through these points, we get the blade as shown by line *H L M*. And, similarly, by taking the horizontal distances of each point above or below the center line *N O*, and laying them off on their respective lines on the side view, we can draw in the projection of the blade by drawing curves through the points obtained. This view should have the propeller aperture of the ship drawn round it to scale in order to be certain of the clearances, which ought not to be less than 3 inches at any point.

* * *

A writer describes in a recent issue of the *American Blacksmith* how he fits brass gear teeth in a broken gear. A dovetail is first cut out at the base of the broken tooth to a depth of about ⅛ to ¼ inch, depending on the size of the tooth and the thickness of the rim. Then two or more holes are drilled in the bottom of the cut, and threaded. Short studs are screwed in and cut off slightly shorter than the height of the tooth. Then a form is made of thin iron plates of the height and width of the tooth and shaped to the proper curves. This form is set with care and two plates are clamped on the ends, and the whole is luted with clay on the sides and ends so as to hold the plates firmly in place to prevent the escape of the molten metal used to make the tooth. The form is filled with melted brass poured from a plumbago crucible. After cooling, the form plates are removed and the tooth dressed down with a file. It is claimed that this method of repairing is successful in mill work and other machinery employing cast teeth.

THE UNIVERSAL MILLING MACHINE PATENT.

The Brown & Sharpe Mfg. Co., Providence, R. I., has sent us photographs of patent No. 46,521, this being the patent granted to Joseph R. Brown, February 21, 1865, for the universal milling machine. The accompanying half-tone reproduction of three pages of the patent is of considerable interest in view of the fact that the universal milling machine has come to be one of the most useful of machine shop tools. The patent is on parchment, and the pages are about 14 x 18 inches.

When the universal milling machine was exhibited by J. R. Brown & Sharpe in 1867 at the Paris Exposition it attracted much attention from foreign engineers and manufacturers, this being the first public exhibition of the machine, which was destined to make the name of its manufacturers known all over the world, and which undoubtedly has had a great influence on the development of the mechanical arts. A comparison between it and the latest type with constant speed drive gives a good idea of the growth of the milling machine in size and power during the past forty years.

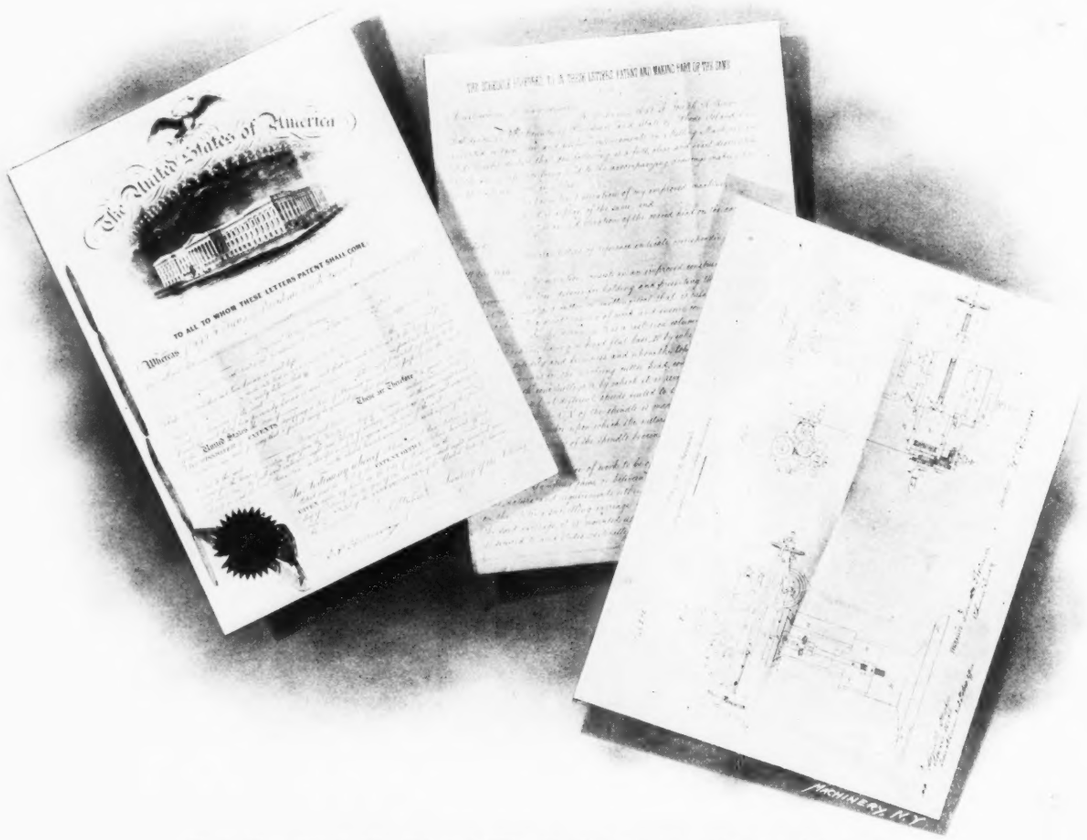


Fig. 1. Three Pages of the Universal Milling Machine Patent granted to Joseph R. Brown.

In this connection we also show in Fig. 3 a view of the old shop in which the original milling machine was designed and built. As most of our readers no doubt know, the business is one of the oldest in New England, having been founded in 1833 by David Brown, and his son Joseph R. Brown. In 1853 Lucian Sharpe became the partner of Joseph R. Brown, David Brown having retired in 1841. The firm was then known as J. R. Brown & Sharpe. The early growth of the business was very slow. In 1853, twenty years after inception, the total floor space was only 1,800 square feet, and in 1857 the total force comprised only 20 men, but in 1872 more than 300 men were employed. In this year the Brown & Sharpe Mfg. Co., which had been incorporated under this name in 1868, removed from the old shop to the present site near the center of the city. The present floor area of the five manufacturing buildings is 436,200 square feet and of the foundry, 160,740 square feet.

TOOTHED GEAR MEMORIES.

INTERNAL.

In ancient days in England, when water wheels were common, there was a large amount of heavy mill gearing work to be carried out. There are no great water powers in Great Britain, but quite numerous mill sites with a fair volume of water and a low fall. In order to get a fair amount of power, the water wheels were made very wide and of the low breast variety. To prevent racking stresses there were large spur

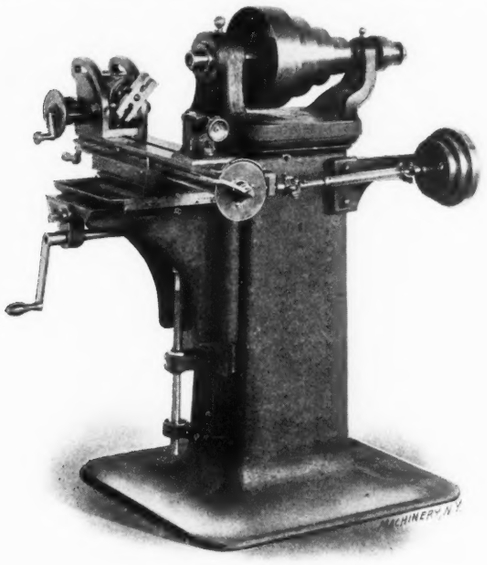


Fig. 2. The First Universal Milling Machine, built in 1862.

toothed gears at the ends of the wheel, and these drove two pinions on one second motion shaft. The large spur wheels were built up of segments bedded on the timber framing of the water wheel. The timber bedding brackets were turned off to a true radius by fixing up a tool rest and letting the wheel run, and turning down the bracket to the true radius to fit the segments. It was customary to lay out the segments on the ground, which had been packed level, and to set them to the radius by means of a trammel, or long board pivoted

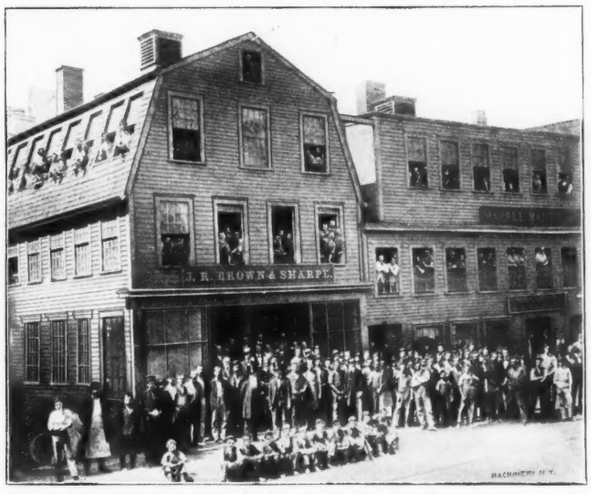


Fig. 3. The "Old Shop" in which the business of the Brown & Sharpe Co. was conducted until 1872.

upon a center post and carrying a scriber. The segments were moved in and out until, when properly butted at the ends, the scriber just touched each segment end when the trammel was revolved round the circle. Then this scriber was measured to the center of rotation and gave the radius on the brackets.

Sometimes, in spite of care, too much was turned off the brackets, and the segments would not bed when butted end for end. This was a very trivial matter. What was one tooth in 375? So one tooth would be cut off one segment and the bedding-down carried out with the smaller wheel of 374 teeth. On one occasion when this had been done the men forgot to do the same by the opposite end wheel, and so there was one wheel of, say, 375 teeth at one end of the water wheel, and there was a 374 tooth wheel at the other end, and both drove equal pinions on the second motion shaft. Such a combination forms a most powerful differential gear, capable of working up an enormous stress. The water wheel was started under these curious conditions, which, it is needless to say, made themselves known by the amount of wreckage produced as regards wheel teeth, all of which were stripped. There was a great wreck.

Another curious oversight occurred in connection with an engine. It was usual, when the engine had not a spur fly-wheel, that is to say, one with teeth directly on the rim face, for a toothed wheel to be built in segments upon projecting brackets cast on the arms of the fly-wheel. The spur wheel was thus slightly less in size than the fly-rim. With the above method of construction the second motion pinion was close alongside the fly-wheel and it overhung its bearing, for there could be no support on the fly-wheel side of the pinion. But on one occasion when a new engine was being put into a mill the fact was overlooked that the engine was at the middle of the building, and that the second motion shaft ran each way from the engine. This was discovered only when it came to putting things together, when of course the fact that the second motion shaft passed through the arm space of the fly-wheel produced some disconcerting moments. The net result was that new fly-wheel arms and a new rim of smaller diameter and heavy section had to be made, in order that the rim might not extend to the second motion shaft. Such were some of the incidents that added color to life in the old shops.

Another very funny incident occurred at Bellhouses' foundry in Manchester, where a large wheel rim was wanted, cast in one piece, and there was not room enough to do this anywhere between the wall and the post of the old-time center post jib crane. Some genius, however, offered a solution of the problem which was at once accepted heedlessly and with acclamation. Let us cast it round here, said he, indicating the ample space of which the crane post formed the center. And cast it round the crane post they forthwith proceeded to do. The error was found out when the time came to move the casting. Only then was it found how much a fourth dimension in space is really required. I am told that if there was a fourth dimension of space one could turn an India rubber ball inside out without having any hole in it through which to do the turning. Presumably, in a fourth dimensional heaven even a cast rim could be gotten off a crane post, fast at both ends to floor and ceiling. But being only—for a time—in a three dimensional "other place," they had to break the rim to set it free.

To-day, when a man has an engine to put up, he waits until the overhead traveler is ready and proceeds to lift all the heavy pieces into place by its aid, just as easily as if they only weighed a few ounces. In the old days, engines were erected with no aid but the hand crab and block tackle. With these, the heavy cylinders, the boss of the fly-wheel, and the great beam, all had to be gotten into place, and it was often necessary to carry such pieces through long distances, and even over other buildings to get them to their final resting place. This work required a considerable degree of judgment and careful handling, for the hand crab was a paltry affair, and I have since marveled at the way we had to risk life and limb in order to get along at all. Once when lifting a four-ton spur pinion with a ¾-inch chain, the chain snapped, and the wheel fell about eight inches with the leading erector standing on its face; it was being lifted in vertical or running position. This man (who never hurt himself or anyone else, but was most risky in his hazards) used the same chain again, lifted the wheel about eight feet, and through a window right above the four men who were working the crab. As they were nervous, he stood with them at the crab handles so that if the wheel fell it would have fallen on him worst of all. He traversed that wheel from "hang" to "hang" across

the engine room and to its place; he threaded the second motion shaft through the eye of the wheel; and had got everything lowered within an inch of its bearing, when the chain again snapped and the wheel fell, but only an inch or less, for the shaft was nearly down on its lower brasses. The salient facts are that the same chain broke at each end of the journey. It might just as well have broken when the great spur pinion hung three feet above the five men when working at the crab handles. They do say that Satan cares for his own; he certainly does seem to have done so effectually that time, and many others, for the man died properly in the end, and not by accident.

Cheap makers of wheels would only make one pattern for a pair of bevel wheels. A pair of true bevels of equal size maintained an equal speed of both shafts, but good makers laid greater value on a hunting tooth, and a pair of equal bevels were always made 1 tooth different. One wheel would have 45 teeth; the other 44 or 46 teeth. Many have heard the story of the hysterical locomotive—a tale founded on this practice, which records how one Sammy built a locomotive valve gear which involved the use of a pair of bevel wheels, and how the engine sawed itself back and forth on the shed tracks like a steering gear engine—always overtaking the phase of its valve gear and finally getting it so far over that the engine ran back, and got as far into the opposite phase—and so on, all because the bevel gears had the hunting tooth.

The old water wheels had their large spur driving wheels built up of many segments, and some of the patterns were very rough and warped with usage, so that the cast teeth were often more or less twisted and out of pitch. They would work noisily at first, but it was usual when the noise was too pronounced to correct it by grinding the teeth—a very simple operation performed with very simple apparatus —water and sifted sand. The wheels being set to work were supplied with sand and water until they ran reasonably quietly. They could not help grinding truly to pitch for there was always some hunting of the teeth even if the wheel and pinion were not prime to one tooth. The heavy bearing teeth got the most grinding and soon the pitch became even.

It was many years ago that we made the first departure from the traditional length of tooth of ¾ pitch, which had once been regarded as short. We made a pair of wheels for a corn mill in the County of Durham, and gave them a length of two-thirds the pitch, and they looked well. It was about that time that the Hawkins translation of Camus on Wheel Teeth fell into my possession; the genial Hawkins fell terribly foul of the men who had stood by chord pitch measurement. He advocated short teeth of only half pitch length, and though this is too long, it was a length I used myself for several years; not that I would not have used much shorter teeth, but that one had to make certain concessions to public taste, and a very short tooth frightened men accustomed to the older lengths. My own advocacy of short teeth dated from the above book, and the idea spread until at last one found teeth with a length on the true teeth faces of only about one-eighth the pitch; but some men also conceded to public opinion in a way they ought not to have done, for they made the teeth with true short faces, and then joined them into apparently long teeth by means of semi-circular arcs below the flanks, and similar arcs above, so that the teeth looked just like a series of corrugations of circular arcs. The arcs were absolutely meaningless, and were hideous and clumsy additions merely to conceal the actual fact of very short teeth. They were, in fact, a sort of mechanical lie or fake construction, offensive to good taste and to mechanical rectitude. If public opinion had to be bowed to at all, why go beyond a certain shortness of tooth? A tooth of one-third pitch should be all tooth if it can be pressed on the purchaser, but to give him a tooth of ⅛ pitch, and build it up to approximately ⅝ pitch by meaningless additions and subtractions of metal of no use, is bad taste and bad concessions into the bargain.

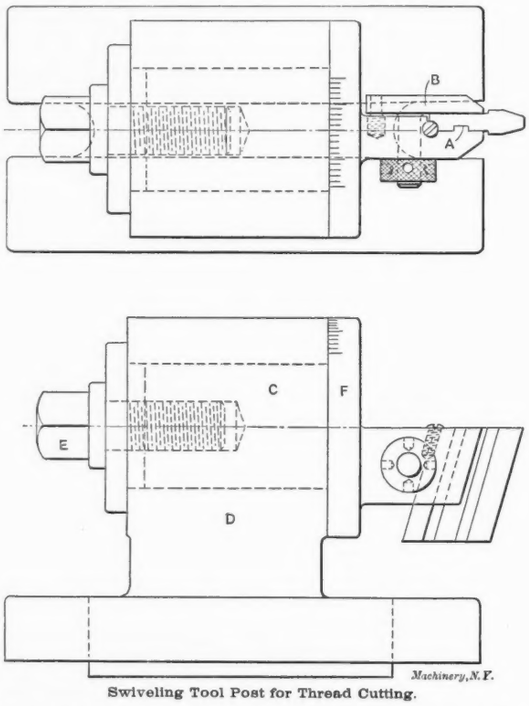
It is known that teeth drive easier when in contact past the line of centers than when approaching. In a full wheel pattern, either of two wheels may be the driver, and it is therefore not practicable to make one wheel with all the teeth projecting above the pitch line, while the teeth of the driven wheel are nearly all below pitch line; for the contact, when the latter became the driver, would be all before the line of centers. Where, however, wheels are molded from a simple gap pattern of two teeth, every pair of wheels may well be thus made, the driver having only points, and the driven wheel flanks only, so that little or no contact takes place before the teeth have passed the line of centers. Such teeth will run quietly.

At one time a very quiet running tooth was made under the patent of one Gee. He argued that wheels run one way only, so he only made one side of a tooth to the proper tooth form. The backs he sloped off so as to get a tooth very strong at the root, and a very little increase in depth of mesh reduced the play or back lash to nothing. By this means he could practically reduce back-lash to a minimum, and his teeth certainly ran very quietly.

* * *

THE INFLUENCE OF THE THREAD MILLER ON TAP MAKING.

With the advent of the thread milling machine the extreme accuracy of thread forms hitherto scrupulously adhered to was sacrificed for the greater commercial advantages in rapid thread cutting. The thread milling cutter, while, as a rule, itself ground to the correct form of the thread, is, when in use, swiveled around a horizontal axis at right angles to the axis through the center of the hole of the cutter in order to



Swiveling Tool Post for Thread Cutting.

conform to the angle of helix of the thread to be cut. By swiveling the cutter in this way the exact form of thread is not duplicated in the screw to be cut, inasmuch as the correct angle of the thread will not be measured in a horizontal plane through the axis of the screw as it ought to be, but in a plane at right angles to the direction of the helix of the thread. It is obvious that the inaccuracy is increased in proportion to the angle of helix; for fine pitches the inaccuracy is so small as to be insignificant for practical consideration, but as the pitches grow coarser, the same diameter being retained, the differences between the correct thread form and the one produced become enough pronounced to demand attention.

It is particularly when cutting Acme threads that this difference is great enough to cause difficulties, because of the fact that the pitches on Acme screws are usually twice as coarse as those on U. S. or V-standard screws. The head of the thread milling machine carrying the cutter has to be tilted over so much in cutting the screw that the dimensions of the thread produced differ by measurable amounts from the standard thread, and if a screw with such a thread is placed in a nut cut with a tap having a correct thread, a very poor fit

will result. The variations are, of course, even greater in the case of multiple threaded screws, and the use of the thread milling machine for cutting such screws may be prohibitive in extreme cases, unless the taps for the nuts are produced in a manner similar to the one used for the screws.

One way would be to mill the taps on screw milling machines. This is also done to a certain extent by manufacturers of these taps. But if it is desired to cut the taps in a lathe, and there are not enough taps to be made to warrant the making of thread tools to suit all the different angles of helix which may occur, a correct thread tool or single point cutter may be used and placed in a tool post or holder capable of swiveling adjustment, so that the tool can be tilted over to the same angle as the milling cutter would be set to in cutting the screw. Such a tool-holder is shown in the accompanying cut. An incidental advantage and saving of expense is gained by the use of such a holder, because of the tool or single point cutter, being set over to conform to the angle of the thread, does not need to be provided with side clearance, but can be made as if intended for cutting a circular groove or a thread of very fine pitch.

The tool-holder shown is provided with a tongue *A* and a clamp *B* to hold single point cutters of the kind manufactured by the Pratt & Whitney Co. The stem *C* of the holder is fitted to a cast iron bracket *D*, which is clamped to the cross slide of the lathe. The screw *E* clamps the holder in position. The shoulder *F* of the holder is graduated in degrees in order to indicate the angle to which the tool is tilted. The holder, as shown, is of the very simplest construction in order to merely convey the idea of the tool. With a little more elaboration in the design a still more efficient tool may result, but for temporary use the one shown will prove efficient.

* * *

A RECORD WITH AN AUTOMOBILE.

A remarkable record was made June 28 and 29 by Mr. S. F. Edge on the Brooklands racing track at Weybridge, near London, England. In twenty-four hours he traveled 1,581 miles with a Napier six-cylinder car. This is at the average rate of nearly 66 miles per hour, and is said to be the greatest distance ever traveled by man in the same length of time. It is noteworthy that notwithstanding the locomotive has done so much to promote the world's progress in increasing the speed and ease of transportation, a car built to run on the ground instead of on steel rails has made a far higher record than any locomotive has ever accomplished. Of course the comparison is not really so very bad for the locomotive, for the automobile record was made on a racing track and under conditions that permitted instant repairs to be made from time to time as they were required. No doubt under similar conditions a locomotive could be made to run as far or further in twenty-four hours. A very important difference is that the locomotive is a practical machine for conveying freight and passengers and earning its way, whereas the motor car is as yet largely the plaything of a sporting class.

* * *

In the August issue of MACHINERY we published a letter from one of our readers concerning industrial life insurance. In this letter the enormous waste in connection with the industrial life insurance companies was pointed out. A remedy of the evil of the present condition in this respect has been proposed and acted upon in Massachusetts, and in that state the conduct of industrial insurance is about to be undertaken by savings banks. Investigations having shown that of the total amount of assessments paid by those insured in regular industrial companies nearly 40 per cent is used for conducting the business, it is gratifying to find that in the Massachusetts savings banks the expenses of management are only 1.47 per cent of the amount of deposits. As industrial insurance is a necessity to the majority of industrial workers, this departure is a very important one. Hereafter it will be possible for the residents of Massachusetts to obtain industrial insurance at actual cost, and, for the same amount expended, about double the previous amount of insurance can be carried, the payments being made easy by applying the installment plan in the same way as do the industrial life insurance companies.

FORGING A LATHE BORING TOOL.

J. F. SALLOWS.*

J. F. Sallows.†

Cold shuts, the starting point of the water cracks so often found in lathe tools, may be caused by heating the steel too quickly or too slowly. In heating too quickly, the center of the bar does not reach the same degree of heat as the outside of the bar, and consequently the outside part of the bar draws out under the hammer more freely than the center, thus causing a parting of the metal. This is the starting point for a water crack when hardening the tool. Heating a tool too slowly, and exposing it to the air either at the top or bottom, decarbonizes the steel, and a poor lathe tool may be the result.

When heating tool steel a heavy fire should be used, a good solid foundation of coke being laid in the bottom of the fire, and the steel should be well covered with coke. The smith must watch the steel carefully and not allow it to remain in the fire and "soak," as is sometimes the case, especially if he has struck a position that is restful, or has started an earnest conversation with his working mate.

When forging a boring tool, a bevel set should be used of the form shown in Fig. 1, having a round corner at *A*. After

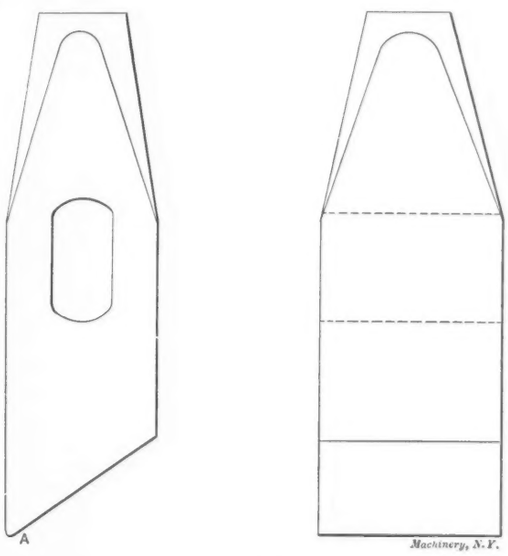


Fig. 1. Bevel Set.

heating the steel, drive the set down making a "V," as shown at *A*, Fig. 2. The rounded corner forms the fillet at the bottom. Some smiths use a large top fuller for making the "V," but the result is a clumsy round corner as shown by the dotted line *B*. If after drawing out the stem of the tool we turn over the lip on the end on an anvil having sharp corners, we shall get another sharp angle that may be the starting point for a water crack. See *A*, Fig. 3. The same also applies to angle *B*, lower view Fig. 3. The anvil used by the tool-dresser

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should have round corners for about four inches from the square end on both sides. Then, when forging a tool that should have fillets in place of the sharp corners, as shown at *A* and *B*, Fig. 4, the means are at hand for forming them. Never use a chisel on a lathe tool if it can be avoided.

When about to lengthen out the stem on a boring tool, it is a common practice to heat the tool to a lemon heat, and with a chisel chop out a piece at *A*, Fig. 5, thus leaving the tool

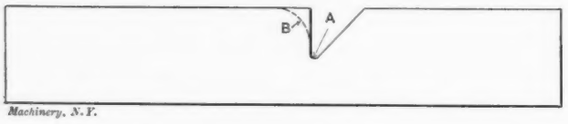


Fig. 2. Characteristic V made by Set.

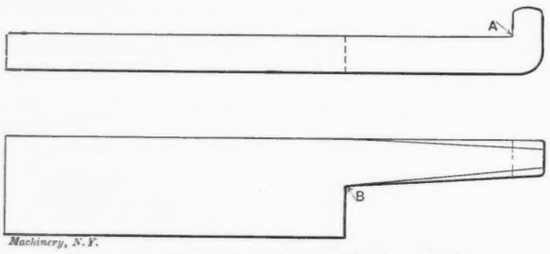


Fig. 3. Tool Blank with Objectionable Sharp Angles.

marred by chisel marks that cannot be removed by hammering. Now, when the tool is used up to that part, it cracks every time it is put in the water. The proper way to lengthen a boring tool is as shown in Fig. 6. Drive the bevel set down as at *A*, then cut off the corner *B*, and draw out the stem to the proper length and size. If a boring tool has a fairly good lip and has to be lengthened in the stem, give the stem a half twist after lengthening, and the job is completed.

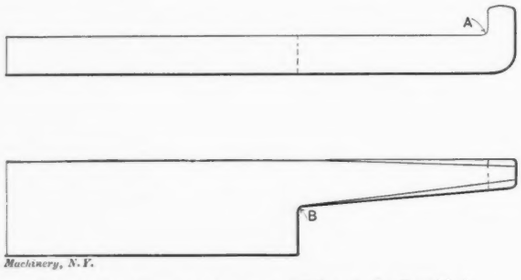


Fig. 4. Tool Blank with Form of Fillets to be Provided.

A common mistake a great many smiths make when tempering or hardening a boring tool is to heat the tool a little too hot, and dip the end into fresh water to a point just above the lip, and hold it still until it is cold. This is bad practice. In the first place the tool-dresser should use salt water for hardening all kinds of tools, for the tools will harden at a much lower heat, and this will do away with cracking. In the

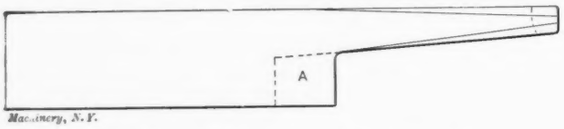


Fig 5. Bad Practice in Lengthening a Boring Tool Stem.

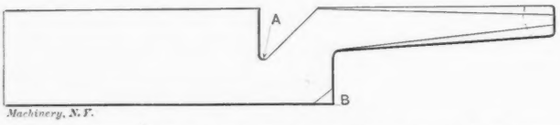


Fig. 6. Recommended Practice for Lengthening a Boring Tool Stem.

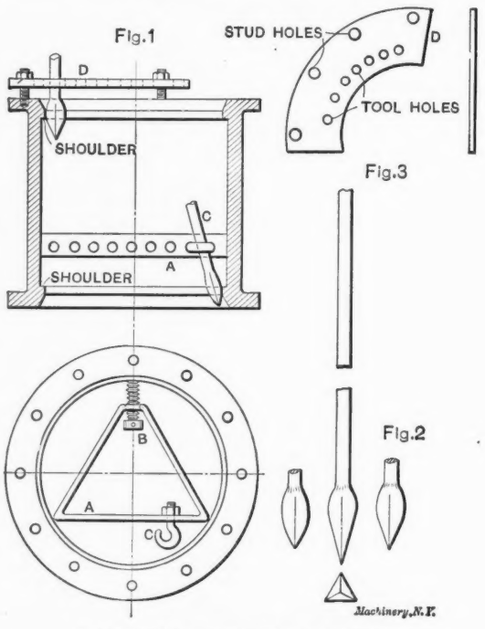
second place the tool should be moved around in the water constantly until ready to be removed.

An inside threading tool should be forged in the same way as the boring tool, except that, when trimming off the cutting part, it is shaped differently, being brought to a sharp point with clearance below. It should be tempered the same, however, as the boring tool, but will not stand to be quite so hard.

ITEMS OF MECHANICAL INTEREST.

SCRAPING OUT THE CYLINDER OF A MARINE ENGINE.

A few months ago a contributor to the *Mechanical World* described how he accomplished the job of scraping out the cylinder of a marine engine. After opening up the cylinder, it was found that the counterbore at each end had not been carried in far enough, and that a sharp shoulder had been formed by the piston at the end of the stroke. This shoulder had to be removed. It was almost impossible to chip it out or to use a file to any advantage. Finally the device shown in the cut was rigged up. The tools used, Fig. 2, were made from ⅞-inch octagonal steel, 4 to 5 feet long, with one end drawn out to a triangular point. In the plan view, Fig. 1, is shown the tool stay *A* for working at the bottom of the cylinder. A piece of bar iron was bent into a triangular shape and welded, the corners being slightly rounded, and one side being longer than the others. At the corner opposite the long side a hole was tapped for a pointed screw *B*. This, when screwed out, together with the two opposite corners



Tools used for Scraping Out a Cylinder.

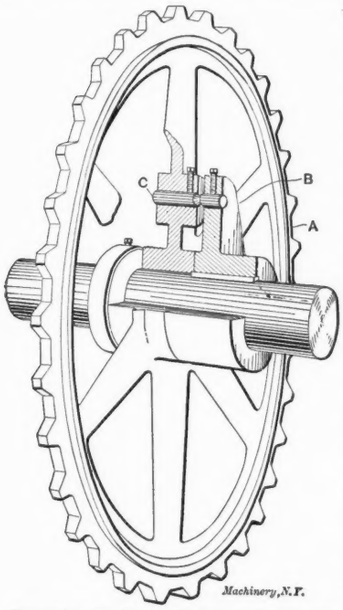
of the triangle, pressed against the wall of the cylinder, and formed a rigid frame. Holes were drilled around the triangle to take a hook *C* against which the tool pressed when cutting. Fig. 3 shows the tool stay *D* used when scraping the top of the cylinder. A piece of plate was cut to about one-quarter circle, and holes were drilled to the same circle and pitch as the studs in the cylinder; inside these another row of holes was provided, large enough to allow the cutting tool to pass through. After a little practice, says the contributor, it is surprising what an amount of metal can be removed, as the long lever gives a considerable amount of power.

THE BREAKABLE PART AS A PREVENTION FOR OVERLOAD.

In a contemporary we find reference made to a design of hub for a chain wheel used in connection with some kind of hoisting apparatus. The design is shown in the accompanying cut. In order to prevent the overload and consequent breaking of other parts of the machinery, a safety device is applied in the form of a pin connecting the driving hub *B* with the hub of the gear *A* itself. As seen from the cut, the gear, instead of being keyed to the shaft, is loosely mounted, and the hub *B* is keyed to the shaft instead. This hub is connected to the chain wheel by pin *C*, which is necked, the extent of the reduction of the neck of the pin determining the amount of power which may be safely transmitted. If the apparatus is subjected to an unusual strain, the pin will break, leaving the wheel free, and thus preventing the breakage of parts which would cause serious accident.

This scheme of applying a breakable part in machinery

to prevent overload and the breakage of more important portions has been resorted to in several classes of work. It is, however, one that can hardly be recommended as an extremely happy one. In the case of a pin for transmitting the power, the temptation of the operator will always be, in case the pin should break, to replace it with one of stronger material so as to prevent the annoyance due to frequent replacement. In the case in hand there is, of course, an obvious temptation, if the pin should break, to replace it immediately with another pin without taking time to neck it down, in which case the new pin may have a power of resistance about double that of the one broken, and the original object of this safety device would be lost. The ideal safety device is one which does not break in the case of overload, but which is simply thrown out of action when the load becomes too heavy, and which can be moved back in position again by simply turning it like a lever. In such a case there is no temptation for the operator to prevent the proper action of the safety device, and there is less risk that the device will be inoperative at the very time when its action is most required. In electrical work this principle has been realized and acted upon, and the old-fashioned fuses which were inserted in circuits in order to prevent overload are being replaced by circuit-breakers. The fuses, in fact, correspond directly to the breakable pin, and circuit-breakers have their direct counterpart in some kind of a lever arrangement in mechanical design which would automatically be thrown out of engagement in case of too heavy load.



Example of a Design having a Breakable Pin as Safety Device.

REPAIRS TO A DYNAMO ENGINE ON A REVENUE CUTTER.

A writer in the May issue of *International Marine Engineering* describes a rather discouraging repair job which was successfully undertaken by the engineers of the United States revenue cutter *McCulloch* in Alaska. The dynamo engine of that craft was wrecked by the breaking of a crank-pin bolt. The damage consisted of a broken piston and ring, bent, and upset piston rod, bent connecting-rod, and smaller injuries.

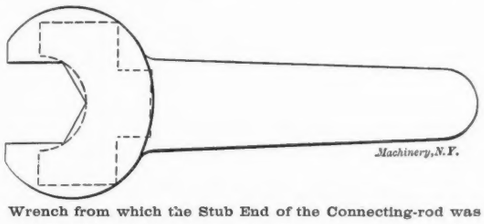


Fig. 1. Wrench from which the Stub End of the Connecting-rod was Made.

For repairs, the material available was sufficient for all purposes except to make a new piston, and the ship had a lathe and drill press. For a piston, a piece of cast iron was secured from the scrap heap at a mine, and drilled out and turned into shape. A spare piston rod on board was found to answer, after a bushing and a new gland had been made for the stuffing box.

When the repairs were practically finished, the connecting-rod disappeared, having supposedly been thrown overboard by a drunken fireman. There was nothing on board from which a connecting-rod could be forged, and a search at the next two points touched at failed to produce suitable material. It was therefore decided to build a skeleton rod of material that was available. The stub end was made from a disused open ended wrench of sufficient dimensions to be cut into shape. The handle of the wrench was cut off, and the jaws were sawed, filed, and machined to the proper size, as shown in the sketch, and holes drilled for the crank-pin bolts.

For side pieces a grate bearer-bar, 7-16 by 2½ inches, was used. These pieces were shaped and temporarily bolted to the stub end with five ½-inch bolts. A block of hard wood, the length of the cross-head pin, was placed between the upper ends to hold the side pieces rigid while the holes for the pin were being drilled. When a new cross-head pin had been turned, the bolts in the stub end were removed, and the pin

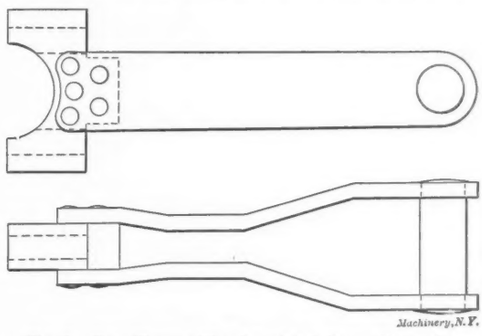


Fig. 2. Two Views of the Completed Connecting-rod.

was shrunk in and peened. The lower ends of the side pieces were then secured to the stub with five ½-inch rivets of soft steel turned to a driving fit, annealed, and riveted cold.

The shape given to the side pieces as shown in the cut was necessary to clear the counterweights on the crank. The completed connecting-rod was found to be sufficiently rigid without the use of distant pieces, and proved to be satisfactory in every way.

THE RESISTANCE OF SOFT MATERIALS.

The note in the May issue of MACHINERY with the above title served as a text for a discourse by the editor of *Wood Craft*, in which he brings together a number of other illustrations along the same lines as those we gave.

He speaks, for instance, of cases in which hardened tool steel bearings have been replaced by soft cast iron shells with great success, especially where the journals had been hardened and ground. This combination of hardened journal and hardened bearing is a rather risky one, as every machine operator who has ever met with it knows. The difference between bronze and babbitt also presents some puzzling peculiarities. Many a hard metal bearing has been replaced by an emergency job of babbitting that, at the time, had nothing but its immediate applicability to warrant its use, but which was found, in service, to make good in every sense of the word. The use of *lignum vitæ* and other wood bearings under water lubrication, and not infrequently in places where they get very little care, is also well known and need not be enlarged upon, beyond referring to the really remarkable showing the bearings often made under these conditions. There is also the common practice of using wooden teeth in water-wheel gearing, where the shock and strain usually form a severe combination.

But a more curious case of metal being quickly worn away by a very much softer substance, plus an abrasive, was quoted from *Stone*. This journal says that yarn with powdered stone can cut a steel bar. The facts to bear out this claim are thus presented. Major McClaughry, warden of the Federal prison at Fort Leavenworth, found a prisoner working away at one of the bars to an outside window. A grating of the same description was placed in his cell, and a guard stationed over him to watch the cutting process. With the limestone dust and silicate from the stone pile, the yarn from his sock and a little water, he cut through the Bessemer steel bar in eighteen working hours. With some fine emery, a chalk line and two wooden handholds to save his fingers, he made a clean cut of the other Bessemer bar in five hours. *Stone* does not say what thickness the bars were nor are we told what reward was earned by the prisoner's persistence.

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SEPTEMBER, 1907.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

PHOTOGRAPHS FOR ILLUSTRATION.

One of the editor's difficulties is getting good photographs for half-tone illustrations. Many subjects are offered, but the majority of photographs submitted lack sharpness and the clear cut quality necessary for "snappy" engravings. More negatives are spoiled by under-exposure than by over-exposure, and the former fault is very marked in most machinery and shop interior photographs.

Machinery and machine shop interiors generally lack sharp contrasts, and all dark surfaces need plenty of time to impress themselves on the plate. There is little danger of over-exposure in the ordinary run of shop interiors. Our experience with an f-8 rectilinear lens in a 5 x 7 camera indicates that with a 16-stop, exposures of from 40 to 50 seconds generally result in fair negatives. This, of course, is only a rough and approximate rule, but we find that it applies very well in most cases.

Another fault of present-day photographs is the very general use of gas-light papers instead of sun-printing papers. The latter are far superior to the former for illustrative purposes, but on account of convenience the tendency is to use gas-light papers almost exclusively. The best photographs that we get come from abroad. Few of our professional photographers are able to produce as good prints as those that are made every day in Great Britain and other European countries.

The gist of the above is that contributors who would please the editor, and who would see the best half-tone illustrations in their favorite trade journal should insist on first-class negatives and "silver" prints for all contributions and descriptions that they may submit.

* * *

THE DROP FACE FLANGED LOOSE PULLEY.

The drop face flanged loose pulley is a feature of shop installation more frequently used in wood-working establishments than in machine shops. A number of machine tool building concerns, especially those who build grinding machinery, have, however, recently made some use of the flanged loose pulley. The theory of its construction is that as the belt is relieved of part of the tension when thrown onto the loose pulley, the latter is not so likely to heat up and cause trouble as it would if it were of the same diameter as the tight pulley.

There is a difference of opinion as to the merits of the drop flanged loose pulley. One concern has hundreds of them running in its own plant, and has adopted them as a standard of all the equipment it furnishes requiring tight and loose pulleys. Another concern speaks favorably of the advantages of the device for driving grinding machinery, although it suggests that relaxing the stress on the belt when running on loose pulleys causes the former to deteriorate and lessens its life.

Another concern, however, points out that the decreased tension of the belt is comparatively slight with long center distances. Suppose that the center distance is 12 feet and that the loose pulley is ⅜ inch less in diameter than the tight pulley; then the shortening of the center distance does reduce the tension of the belt, but ordinarily not so much but that the loose pulley is still under considerable pressure, sufficient to make it run at full speed. In fact, the drop face pulley almost invariably runs faster than normal speed, inasmuch as its diameter is reduced. From this it appears that the reduction of diameter to reduce the belt tension tends to increase, if anything, the danger of heating on account of the more rapid rate of rotation.

One well-known grinding specialist does not hesitate to characterize the drop face pulley as an example of mechanical quackery, and further adds that there is much of this sort of thing in wood-working machinery design. If a loose pulley heats, it is pretty good evidence of insufficient lubrication or length of bearing, or both. Altogether it would appear that the solution of the loose pulley problem in rapid running machinery is simply long bearings and provision for constant lubrication. When these are provided, it will be unnecessary to resort to dropping the face or any other expedient of like nature.

* * *

DYNAMIC BALANCING.

The article on another page of this issue on balancing cream separator bowls is, we believe, a contribution to general knowledge of a somewhat obscure subject. It is a brief description of the method followed in a large factory in adjusting the rotating part of a dairy machine, which runs at a normal speed of about 8,000 revolutions (say 10,000 feet at periphery) per minute. At so high a speed it is positively necessary that the rotating part be put in a state of dynamic balance. This may be a quite different condition from a standing balance, as every well-versed mechanic knows. An armature, for instance, may be in perfect standing balance, and still vibrate badly when run at speed. The reason is simply that somewhere within its length there is an excess weight on one side that is not balanced directly opposite or in the same plane at right angles to the shaft. The fact that there is an exact equivalent to the excess at some other point in the armature length on the opposite side of the shaft, does not answer. The effect of centrifugal force at high speeds is enormous in proportion to weight, and small fractions of an ounce, unsymmetrically located, may quite easily be sufficient to perceptibly spring a comparatively large shaft, this force being 1,500 to 4,000, or more, times the weight in cream separator apparatus. The discovery of the exact seat of trouble is not always a simple matter, and to remedy it is, indeed, often extremely difficult.

The fact that some cream separator makers claim to make bowls that do not require balancing by the *addition* of fused metal to the unbalanced portions does not vitiate the principles enunciated. The fact is that, no matter how accurately the machine work is done, the minute variations in homogeneity of all metals whether rolled, forged or cast, make it entirely necessary to balance by test. Whether it is done by addition or subtraction of material is merely a matter of practice to be determined by individual preference.

The article referred to is a shop man's description written for other shop men, and is a good example of the practical matter that MACHINERY aims to publish. It may easily be worth the price of several years' subscription to those who have to do with the balancing, and no mechanic knows how soon he may be called on to handle work of just this character.

THE STEEL TRUST AND THE TARIFF.

It has been said with a great deal of truth that the tariff is the mother of monopolies, although, of course, there are monopolies which are not fostered by the tariff. At the same time there are industries which remain competitive whether there be a tariff or not. These industries are those which depend mainly upon individual enterprise, skill, and hard labor for their existence. Such industries, however, which depend merely upon their access to natural resources, such as coal, ores or lumber, for instance, are likely to become monopolies when they have been able to corner the supply of a special necessity. In such cases the tariff is plainly the nurse of special privileges, and serves no other conceivable purpose than that of enriching the privileged few at the expense of the many. Consider for a moment the case of the steel industry of the country. There is no exaggeration in saying that it is virtually controlled by one single corporation, a gigantic monopoly, which can command its own prices from those who use the product, whether the users be the machine builder, the structural contractor, the railroad engineer, or in the last hand, the general public. This company produces from one-half to two-thirds of all the iron and steel used in this country. Of all Bessemer steel ingots and castings, for instance, the production of the United States Steel Corporation amounted to 67.4 per cent in 1905; of wire rods, 69.9 per cent; of rails, 53.6 per cent; of structural shapes, 54.6 per cent; and of wire nails, 66.1 per cent. This operation also controls the greater portion of the ore lands in this country, in fact, according to the best authorities, from 75 to 80 per cent of all the ore land of the Lake Superior region, which at present constitutes practically the only cheap supply of workable good iron ore in this country. The monopolized value of the control of these ore lands it would be futile to try to estimate. In view of all this, it seems as if we ought to be ready to recognize, as a nation, that the time has come when even the most avowed believer in protection cannot help but see the fallacy of our present course.

When protecting our output of steel and iron by a tariff, we protect no infant industry. Moreover, the steel mills of the country cannot at the present time supply the demand for their product. The country has reached the point of development where the domestic supply is insufficient. We have been forced to import steel and iron, tariff or no tariff. What a farce then to burden our legitimate industries with this import tax in the name of protection to domestic enterprise, when this latter cannot possibly supply the raw material necessary. The only purpose the tariff serves under such conditions is to permit the interests which practically control our enormous natural resources of iron ore to exact from the users of steel an unreasonable tribute. When it is possible for British makers of steel to ship it all the way to San Francisco, paying an ocean freight rate of $5.90 a ton, pay the tariff, and still sell in competition with our own steel monopoly, then it appears to be plainly in evidence that we are paying slightly more for our domestic steel than it is actually worth, and that a tariff which produces such abnormal conditions is worse than useless.

* * *

INVISIBLE ECONOMIES.

S. H. BUNNELL.*

The effect of distributing the shop expense among the various paying jobs is to obscure its details, particularly to obscure the proportion of wasted expenses, lost time and the like, which may be caused in particular by the doing of certain classes of work, but which are, by the general system of distribution, hidden from view and spread over all, with the result of increasing the computed cost of everything, and diminishing the profits on all. It is an important part of the manager's duty to investigate invisible losses of all kinds, and to conduct matters so as to reduce these as far as possible.

Among such losses are those due to faulty arrangement of plant, so that unnecessary steps must be taken by workmen. There is little difficulty in transporting material by tracks or cranes over almost any desired distance, and in shop work this expense is not a large item, though in the manufacture of steel and similar work, where the masses transported are enormous, it becomes of much greater importance to reduce unnecessary transportation by arranging the plant so that material may progress readily from one operation to the next. The steps taken by workmen, however, cannot be disregarded, and every unnecessary walk is so much unnecessary expense to the shop. Toilet rooms are often arranged at great distances; tool-rooms and storerooms are so located, in the endeavor to concentrate supplies and reduce the expense of caring for them, that many workmen have to walk long distances several times a day. It is easy to compute the loss in dollars and cents due to the time taken by an average man to walk one hundred yards and return. It will generally be found from such calculation that the expense of dividing tool-rooms is more than covered by the resulting saving, although this will never appear in dollars and cents on the books except as a reduction of general expense. In many cases the transportation of tools can better be taken care of by the use of cheap messenger boys, thus saving the time of the expensive men. Unnecessary writing on workmen's time cards, or requisitions for material, and on other reports which must be kept by workmen, more or less careless with such matters, but possibly earning good wages, may involve a large unnecessary expense. A computation of the number of seconds taken by a workman to find his bit of pencil and write a dozen words on a piece of paper or card held on his knee, or against a post, or some rough surface, may show that the employment of a special clerk to make out these cards would result in a large saving. Further, the cards written by the clerk could be more quickly handled, and necessary records made from them with small chance of error, while the time lost by the cost clerk's force in looking up errors and obscurities on time cards written by workmen will generally amount to much more than the cost of making out the cards in the first place.

The physical comfort of the workmen, due to spending their time in a well-lighted and comfortable shop with clean floors, and neatness visible everywhere, is a valuable adjunct in saving lost time. Mental satisfaction is also important. A raise of pay when requested may be expensive for the shop in one way, but the refusal of the raise is certain to be more expensive, as the workman will not equal his former efforts after a disappointment of this kind. Almost everything, however trivial, has its bearings on the expense of getting out the shop product, and too much care cannot be given to reasoning out the probable effect of each move, even though time cannot be afforded to go deeply into all such small matters. The outsider coming into a shop is often able to see chances for saving in what may be called "invisible expenses," which have entirely escaped the men employed there. It is a common occurrence that a city will refuse taxation sufficient to pave an important street and provide a good bridge, while a large number of its inhabitants are at the same time losing many times the amount that would be required for such taxes in hauling small loads, and in unnecessary wear and tear on their vehicles over this same street. The good roads agitation has brought this point clearly before the public, and the agriculturalist has been held up to ridicule for his refusal to assist the cause of road improvement, while he himself was losing every year fifty times the amount he would be called upon by the broadest scheme of road improvement to contribute to the general good. The man in the machine shop office should not have his point of view limited to the direct expense accounts, but the indirect expense should receive more, if anything, of the manager's time and skill, and the obscure and invisible losses should be sought out with the utmost persistence.

* * *

We hear a great deal spoken of this or that new bridge as being the longest in the world. As a matter of fact, states *Railway and Locomotive Engineering*, the longest bridge is located in Sangong, China, and is called the Lion bridge. It extends five and a quarter miles over an arm of the Yellow Sea, and is supported by 300 huge stone arches. The roadway is seven feet above the water, and is enclosed in an iron network.

* Address: Watertown, N. Y.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

According to a news item in the *Pittsburg Despatch* of July 1, the United States Steel Corporation intends to gradually replace the steam power for the blowing engines with gas engines, using blast-furnace gas.

The steel ship may properly celebrate its 50-year anniversary this year. It is stated that the first steel ship ever built was the paddle steamer *Ma Robert*, constructed in 1857 for the Livingstone expedition. The fifty-year anniversary is indeed worthily celebrated by the completion, in the same year, of three such giants as the *Lusitania*, the *Adriatic*, and the *Kronprinzessin Cecilie*.

According to *Page's Weekly*, the municipal council of Paris has adopted a resolution in favor of a project of making Paris accessible to large sea-going vessels by the construction of a large canal from Paris to the sea. The council has two schemes under consideration. The first would utilize the Seine, while the second consists in the creation of a maritime canal from Paris to Dieppe.

Some weeks ago the results of the experimental trials of the *Lusitania* were made public, and they are regarded by her builders as being extremely satisfactory. The vessel obtained a speed of 25 knots, and her engines performed splendidly. Taking into consideration the fact that the *Lusitania* was not running under full pressure at the time of the trials, the results are considered remarkably good.

The production of gold in 1906 was nearly double that of ten years ago, and materially larger than that of the preceding year. The world's production of gold is still on the increase, and it has been estimated that in 1907 the total output will be nearly ten per cent larger than that of 1906. Transvaal is producing the largest amount of any country, the United States coming in the second, and Australia in the third place.

It is reported by *Engineering* that the Russian government has decided to proceed with the construction of a double track on the Trans-Siberian railroad. This step has been taken because high military officers have arrived at the conclusion that if the Trans-Siberian railroad had been double-tracked during the war with Japan, the result of the conflict would have been different, as Russian troops could have been despatched to Manchuria much more rapidly.

In reporting to the American Foundrymen's Association upon tests made with cast iron containing nickel, James B. Webb states that the results of the tests do not indicate a marked improvement in the physical strength of the castings, and bear out the supposition that nickel in cast iron is either not distributed uniformly enough to do much good, or else will find its best use in special classes of the metal freer from the high percentages of impurities incident to the ordinary castings. These tests were undertaken on behalf of the association, and authorized at the convention last year.

In *Annalen der Physik* of July 5, an account is given by Mr. M. Gildemeister of some experiments which he has carried out in order to find how long a time it takes for the magnetism in an electro-magnet to disappear after breaking the circuit. He states that 1-300,000 second after breaking the circuit, the magnetism has gone down to one-half, and after 1-150,000 second to one-tenth its original value. After 1-50,000 second only the residual magnetism is left in the magnet. The core of the electro-magnet which was used for these experiments consisted of a great number of very fine low carbon iron wires.

An interesting comparison between the cost of operating automobile fire engines and horse-drawn engines has been made in Hanover, Germany. This city was the first one in that country to procure a complete automobile fire engine service. It appears that while the first cost of the engine and horses for the horse-drawn service is $11,050 as compared with $13,090 for the automobile, the cost of maintenance is so much less for the latter fire engine that already at the end of the first year the automobile service is the cheaper one, and at the end of five years there will be a total saving of nearly $15,000. If these figures be correctly arrived at, it would seem that the automobile would, before long, entirely occupy this field.

A new tube railway has been opened in London, having a total length of eight miles. This underground railway is remarkable in several respects. It rises 272 feet in its course, and at one point it is 250 feet below the surface, one station being 192 feet under the surface. This is the sixth underground electric railway in operation in London, and five more are projected or under construction. The subways in London differ from those of New York City in that all run at a considerable depth, from 50 to 100 feet below the surface being a common location. In so doing, the subways do not interfere with surface conditions, or conditions near the surface, such as gas and water piping systems, etc.

The British Thomson-Houston Company has supplied the *Times Engineering Supplement* (London), with the results of tests made upon one of four Curtis turbines installed at the Fisk Street station of the Commonwealth Electric Company of Chicago. This turbine, which is rated at 9,000 kilowatts, was tested at loads varying from 5,374 kilowatts to 13,900 kilowatts, or from 60 per cent load to 55 per cent overload. The steam pressure ranged from 176 pounds to 198 pounds per square inch, and the vacuum was fairly constant about 29.50. The steam was superheated 116 to 148 degrees, and the consumption in pounds of steam per kilowatt-hour ranged from 12.9 to 13.6. The constancy of the consumption over so wide a range of load is remarkable.

While speed indicators on railway trains do not seem to have met with great favor on American or British railroads, they are very commonly used in continental Europe. According to *Railroad Men*, in France every passenger engine is equipped with this instrument. On nearly all the lines on the Continent their use is customary, and in some countries even main-line freight engines are so equipped, and the indicators are considered quite as important as steam gages and automatic brakes. It would seem that their use would tend to minimize accidents caused by fast running. The indicator not only shows constantly the speed at which the train is running, but records it in a locked box to which the engineer has no access. The trip record is taken to the office when the engine completes the run. There are said to be 20,000 indicators in use in Europe.

Since the use of concrete had been introduced in this country, the uses to which it has been put have been many and varied. One of the most remarkable departures in the direction of the use of reinforced concrete is that of making concrete telephone and telegraph poles from this material. Nearly a year ago experiments were begun at Richmond, Ind., with reinforced concrete poles. These poles were 30 feet in height, octagonal in shape, and tapered toward the top, provided with gains to be used in climbing and for the insertion of cross arms. A number of these poles were erected on one of the main lines of the company's road, and a short line was constructed wholly with concrete poles. After a year of service it has been found that these poles give as much satisfaction as do wooden poles, and that they have the additional quality of being almost indestructible.

Some interesting statistics are given in the *Archiv für Eisenbahnwesen* respecting railway mileage in various countries. It is estimated that the total length of lines constructed and open all over the world, down to the end of 1905, amounted to 562,436 miles. The annual rate of mileage increase varies from about 3.4 per cent to 2.3 per cent; the total increase in the number of miles open for traffic in the five years ended with 1905 was 10.9 per cent. America, North and South, naturally heads the list of the different continents with a gross total of 285,781 miles. Europe is but a poor second, with a total of 193,133 miles; Asia follows next, with 50,562 miles; then comes Australia, with 17,431 miles, and Africa brings up the rear, with 16,528 miles. It is stated that the cost of land and construction of the European railways is about double that of the lines in any other quarter of the globe. The assumed total expenditure for European railways amounts to about $23,000,000,000, and the cost of the railways in all other parts of the world nearly $22,500,000,000. The cost per mile of European railways averages about $120,000, and of the roads in the United States $54,000.

The use of electrical power in modern steel mills is now extended to cover practically all the machinery of the plant, the systems of telpherage, conveyors and practically all the appliances for handling the hot metal, being now universally driven from individual motors. At the Gary plant of the Indiana Steel Co., the rail mill will probably require the greatest amount of power. This mill is situated about a half mile from the power house in which the sixteen huge units will be housed, and will consume approximately 10,000 kilowatts to operate the induction motors which drive the main rolls. These motors range in capacity from 2,000 to 6,000 horse-power, and three of them have overload capacity of 9,000 horse-power for an hour. The breaking-down stands in the rail mill for reducing ingots to fair-sized blooms, will be driven by two 2,250-horse-power motors. The blooms will then go to the blooming mill, which is operated by one of the 6,000-horse-power motors, and from this they will pass to the mills driven by two 4,500-horse-power motors, receiving their finishing passes in the mill driven by a third 2,500-horse-power motor. All the tilting and feed tables for the various passes, all hot saws, hot and cold pull-ups, the transfer tables, straightening machines and cold saws, and all auxiliary machinery of the mill will be driven by electric motors.

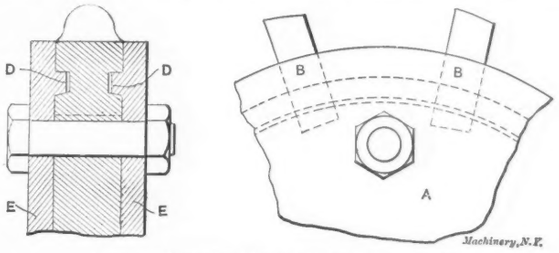
THE VALUE OF OLD VALVES FOR SCRAP METAL.

According to the *Brass World* there is no old metal, with the exception of copper wire, that commands so high a price from the brass founder as "old valves." A foundryman is always willing to buy them, as they are the best material he can obtain. There is no class of brass castings made with more care than valves. Not only must the metal be of a good bronze color, but it must cast well, so as to stand the pressure test. It must also contain sufficient tin to harden it and prevent its bending while being worked, or when screwed to the pipe. It is a pretty good metal that will stand these requirements, and a valve that has passed inspection must surely be of good quality. There may be said to be practically two standard valve mixtures on the market to-day. One of them is very extensively used and all ordinary grades of valves are made from it. The mixture is as follows: Copper 86 per cent, tin 5 per cent, zinc 5 per cent, lead 4 per cent. For the best grade of valve the following mixture is usually employed: Copper 86 per cent, tin 7 per cent, zinc 4 per cent, lead 3 per cent. Scrap cocks should always be carefully sorted from the valves, as the quality of metal used in them is inferior. In sorting over the material, also, the founder should take care that no iron wheels are included. The wheel is the only part of a brass valve that is made of iron, so that the rest may be thrown in indiscriminately. In general, however, if a first-class quality of metal is wanted, the best material will be found in valve bodies. There need be no hesitation in melting them up as they are, without the addition of any other ingredient.

IMPROVED INSERTED BLADE MILLING CUTTER.

The Mechanical Engineer.

The accompanying cut shows an improved method of securing the teeth of inserted-blade milling cutters to the body. This arrangement is the joint patent of H. S. Moorwood of Onslow House, Brocco Bank, Sheffield, and J. M. Moorwood of Millhouses Lane, Millhouses, Sheffield, England. The body *A* of the cutter is provided with slots *B* to receive the cutter-blades as usual, but the lower ends of the cutter blades, as well as the portions of the body between the blades, are grooved to receive the annular projection *D* of two disks *E* which are screwed tightly to the body, thus holding the blades



Improved Inserted Blade Milling Cutter Design.

in place. The groove in the blades as well as the annular projection on the side plates are slightly tapered on the inside so that the inserted blades are drawn inward and held firmly against the bottom of the slots for the blades in the body, when the bolts are tightened. While, without modification, this method may have its difficulties, and may be rather expensive, the idea involved is commendable, and may serve to suggest something of better practical application.

SECURING UNIFORMITY IN PHOSPHOR-BRONZE SPRINGS.

The Brass World, April, 1907.

Among the copper alloys, there is none which is surrounded with so much uncertainty as phosphor-bronze. This is particulariy true of springs made of this material. If a spring of a material other than steel is desired, phosphor bronze is usually specified. If the mixture is rightly made, such a spring cannot be surpassed by anything except steel. The action of the phosphorus in phosphor-bronze is to reduce the oxides of copper and tin that are formed in melting. Any amount over and above this quantity acts deleteriously and injures the metal. Experience has taught that if the phosphorus in rolled metal exceeds 0.05 per cent, the bronze is injured.

The greatest variation in rolled or drawn phosphor-bronze, however, is caused by the tin content. A bronze which contains only 3 per cent of tin is inferior to one which contains 8 per cent, though both may be phosphor-bronze. On account of the difficulty in the rolling or drawing of phosphor-bronze containing a high tin content, manufacturers will substitute a lower percentage if it is possible to do it. The presence of zinc is also an unsatisfactory condition. A good spring should contain only copper, tin, and a very small quantity of phosphorus.

Those who have had trouble with phosphor-bronze springs should ascertain whether their troubles are not caused by the absence of the necessary amount of tin, or the presence of zinc. When rightly made, phosphor-bronze is an excellent spring metal, but if not, it is inferior to yellow brass. The "temper" is produced by cold-rolling, of course, but unless plenty of tin is used in the mixture, the requisite "temper" cannot be produced, no matter how much the metal is rolled.

GENERAL CONCLUSIONS FROM THE A. C. A. SEALED BONNET AUTOMOBILE CONTEST.

Albert L. Clough, in the *Horseless Age*, June 26, 1907.

On June 19 the Automobile Club of America arranged what has been termed a sealed bonnet contest; that is, all the machines taking part in the contest were completely equipped before the start, and then seals were affixed to all operating parts. The contest consisted of a run over a more than 600 mile long route, accomplished without adjustment or repairs of any kind, and lasted for four days. The outcome of the

contest shows that 41, out of 47 cars entering it, accomplished the feat of being driven the distance mentioned over good roads without suffering any derangement in their machinery. This is a remarkable showing, and a demonstration of the present reliability of modern motor cars. It is a result which is believed to have been unattainable one year ago, and which two years ago would seem to have been absolutely impossible. The mileage equals that which the average private car covers in an entire month, and is, in fact, in excess of the mileage which a locomotive or trolley car covers without being laid off for attention and repairs. But, of course, the result of the contest must not be understood to mean that 87 per cent of all modern motor cars are capable of covering 600 miles without adjustment or repairs, for the cars concerned in this test were of higher grade than the average, comparatively few of the lower priced cars having entered the contest. Nor can it be said to be a marked distinction for the 41 cars, out of the 47, that they accomplished the feat, or that they were of superior make to the remaining ones, for the element of chance in a contest like this is greater than in a contest of any other kind.

The conclusions reached are more as to the general reliability of motor cars as at present manufactured than in regard to the distinct superiority of the cars that accomplished the feat. One car, for instance, built by a company of established reputation, and known as being reliable, suffered the breakage of an inlet valve spring. It is hardly likely that the inlet valves of this engine were inferior to those of many of the other cars, or that in this engine there would be, in say 10,000 miles of running, any more broken valve springs than in the other cars in the same period of service. It would therefore be unjust, indeed, if any one draws the hasty conclusion that because a particular car has been unsuccessful in this contest, it is necessarily inferior to any of the successful ones. A good showing for the automobile was that in only two instances were cars crippled by the breakage of any essential part, and in one of these cases the breakage happened after due warning. The final conclusion of the sealed bonnet contest, for this reason, is simply that it furnishes the strongest vindication that we have ever had of the adaptability of motor cars in general, but that it throws no certain light upon the reliability of different makes. If another contest of this sort is ever run, it is obvious that much harder roads will have to be selected, and the contest must be prolonged greatly in regard to mileage.

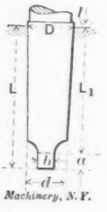
STANDARD GERMAN TAPER SHANKS.

Zeitschrift für Werkzeugmaschinen und Werkzeuge, July 15, 1907.

Since a long time back the Association of German Machine Tool Manufacturers has been endeavoring to establish a standard system of taper shanks, based on the metric system, to replace the Morse system, which on account of its irregularities and its basis of English measurements is not considered desirable in Germany. With the exception of a few machine tool builders who fear the effects of such a move, particularly on their export trade, the proposition has met with favor not only on the part of machine tool manufacturers, but on the part of their consumers as well, and many governmental officers and state railway shops have pronounced themselves in accord with the movement for a metric standard taper shank, based on a constant taper for all sizes. The difficulties that necessarily must follow the introduction of a new standard are duly appreciated, but the final gain is expected to be great enough to outweigh the unfavorable influences. The introduction would be gradual, and thus cause as little disturbance as possible.

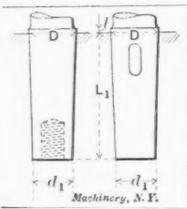
The taper of the proposed standard is *one in twenty* or 0.6 inch per foot, which, in fact, is the same taper as proposed by Mr. Oscar J. Beale in the Jarno taper system, and also the same as in one of the Morse standard tapers, the No. 1. In the accompanying tables are given the dimensions for the proposed standard system of taper shanks, both with and without tang, and the dimensions for the hole in the socket. All dimensions are in millimeters. The first four sizes, Nos. 1 to 4, correspond closely to Nos. 1 to 4 Morse standard taper. From and including No. 5, the system is based on the formulas given, but the *first four sizes do not conform to these formulas.* No dimensions have been given in this standard system for unessential details, such as the radius of the cutter for milling the tang, etc., as this was not considered necessary.

TAPER SHANKS, WITH TANG.



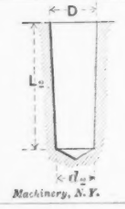
		1	2	3	4	5	6	7	8	9	10	11
Largest diameter....	D	12	18	24	32	40	50	60	70	80	90	100
Length of taper in socket.....	$L = 2\,D + 60$	60	80	100	120	140	160	180	200	220	240	260
Projection outside of socket.....	$l = 0.1\,D$	4	4	4	4	4	5	6	7	8	9	10
Smallest diameter...	$d = 0.9\,D - 3$	9	14	19	26	33	42	51	60	69	78	87
Length of tang.....	$a = 0.2\,D + 8$	8	10	12	14	16	18	20	22	24	28	28
Thickness of tang...	$b = 0.3\,D + 2$	5	6.5	8	11	14	17	20	23	26	29	32

TAPER SHANKS, WITH THREADED HOLE OR KEYWAY.



Largest diameter....	D	....	.....	24	32	40	50	60	70	80	90	100
Length of taper in socket.....	$L_1 = 1.8\,D + 52$	...	.....	88	106	124	142	160	178	196	214	232
Projection outside of socket.....	$l = 0.1\,D$	....	.....	4	4	4	5	6	7	8	9	10
Smallest diameter...	$d_1 = 0.91\,D - 2.6$	....	.....	19.6	26.7	33.8	42.9	52	61.1	70.2	79.3	88.4

DIMENSIONS FOR SOCKETS AND TAPER REAMERS.



Largest diameter...	D	12	18	24	32	40	50	60	70	80	90	100
Length of taper in socket.....	$L_2 = 1.85\,D + 52$	52	71	88	108	126	144 5	163	181.5	200	218.5	237
Projection of reamer, minimum	l	4	4	4	4	4	5	6	7	8	9	10
Smallest diameter...	d_2	9.3	14.45	19.6	26.6	33.7	42.775	51.85	60.925	70	79.075	88.15

THE WORKING OF LARGE GAS ENGINES.

Times Engineering Supplement.

At a meeting of the British Society of Engineers, Mr. George Moore read a paper dealing with the working of large gas engines. It was pointed out that while the use of large gas engines had increased remarkably during the past few years, very little information had been given as to the characteristics and behavior of these engines while in operation. Continental engines are divided by the author into three different types: the double-acting 4-cycle type, the Ochelhaüser and Körting types. The Körting and Ochelhaüser engines possess the advantage over the Otto cycle type that there is no need of water cooled exhaust valves. The thermal and mechanical efficiencies of the Körting type, however, are comparatively low. Trouble has arisen in this engine, as well, in regard to the piston, owing to its great size and weight, and certain designers make a piston in three pieces to overcome certain difficulties in this respect. The complicated form of the cylinder head of the Körting engine renders it liable to crack, and experience has shown that the greatest wear takes place in the middle of the cylinder near the exhaust ports. Gas engine designers are still in doubt about whether it is expedient to chamber the tail rods, and practical experience seems to bear out that the tail rod itself is not of any great advantage on engines of less than 500 horse-power. In the actual running of large gas engines it has been found that one of the most persistent troubles is the liability of pre-ignition, and with large engines having cylinders of about 24 inches in diameter, pre-ignition is never entirely absent when using producer gas. The author's experience is that Mond gas is satisfactory for larger engines if reasonable care is taken. Gases containing a high percentage of hydrogen are not very suitable, because the hydrogen ignites at a comparatively low temperature, and a high percentage of this gas is liable to cause pre-ignition. The question of the value of positive scavenging has not, as yet, been settled in regard to the four-cycle type of gas engines. In regard to various methods of governing, it is pointed out that the by-pass governor valve, commonly used on the Körting engine, does not work satisfactorily with producer gas.

POWER REQUIRED FOR MILLING MACHINES.

S. Streiff, in *Werkstatts-Technik*, January, 1907.

The following experiments for finding the power required for driving milling cutters have been carried out on a special milling machine. The results are given in the accompanying table. Only the results of such experiments where the power required was determined definitely are taken into consideration. A number of experiments, where either the time of cutting was insufficient to get a good average, or where some other disturbing factor entered in the experiment, have been left out of consideration. The milling cutters used were made from high speed steel. It will be seen from the table that a proportionally higher amount of power is required for light milling than for heavy, a result that is rather natural, as the running of the machine itself, irrespective of the work being performed, would require practically the same amount of power in either case. It will also be seen from the table that the depth of the cut does not increase the power required in the same proportion as does the width of the cut, and that work with a heavy feed and a deep but comparatively narrow cut requires far less power for the amount of metal removed than does a slow feed, and a cut of moderate depth, but wide. In general it seems as if a slow feed is particularly uneconomical in the use of the milling machine. The figures in the table have been transformed into the English system of measurements, to facilitate comparisons.

TABLE OF MILLING MACHINE EXPERIMENTS, SHOWING RELATION BETWEEN FEED, DEPTH OF CUT, AND POWER REQUIRED.

Number of Experiment.	Number of Revolutions of Cutter per Minute.	Feed		Cutting Speed of Cutter per Minute, feet.	Depth of Cut, inches.	Width of Cut, inches.	Power Required, H. P.	Metal Removed per Hour, pounds.	Power Required per Pound hour, H. P.
		Per Minute, inches.	Per Revolution, inches.						
1	24	2.46	0.10	37	0.26	23.6	25	245	0.102
2	24	3.50	0.15	37	0.26	10.2	17	150	0.113
3	24	4.35	0.18	37	0.14	9.8	17	97	0.175
4	24	3.50	0 15	37	0.49	9.8	27	490	0.055
5	19	4.33	0.23	29.5	0.28	9.3	17	331	0.051
6	23	4.17	0.18	36	0 28	20 5	27	386	0.070
7	23	4.17	0.18	36	0.28	9.8	20	183	0.109
8	40	1.89	0.05	64	0 24	10.2	17	74	0.230
9	40	3.94	0.10	64	0.37	13.8	21	331	0.063
10	40	5.79	0 14	64	0.16	16.5	17	123	0.138

PRECISION GRINDING.

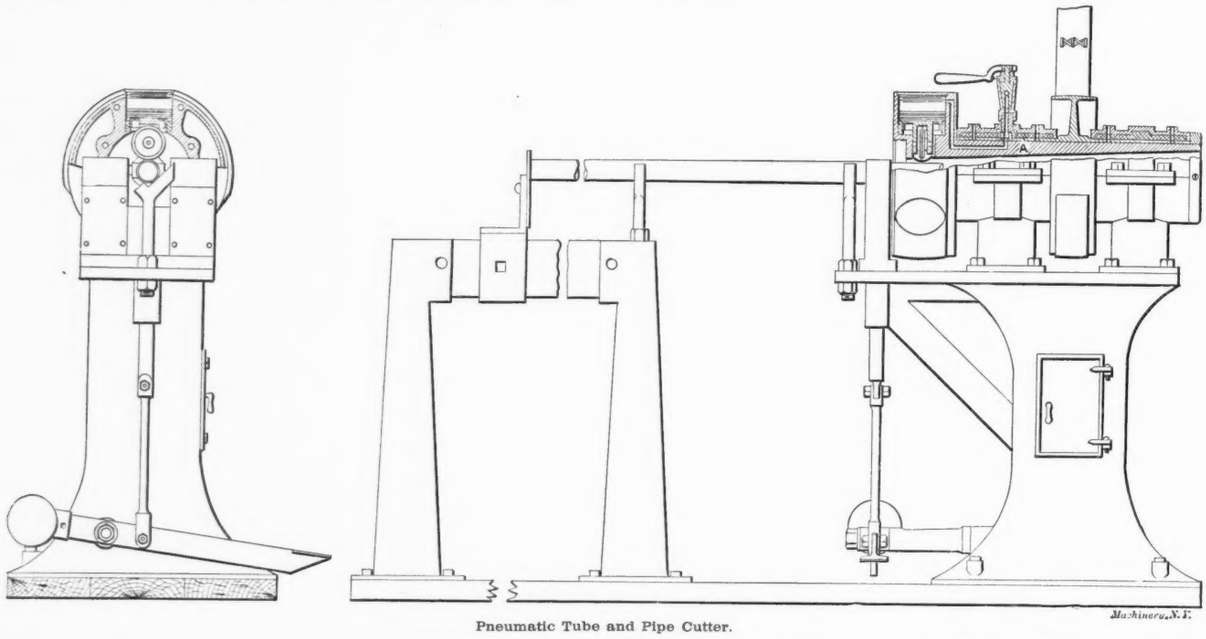
Paper by H. Darbyshire, read before the Engineering Conference of the British Institution of Civil Engineers.

Speaking comparatively, the gratifying advantages that may be obtained from the use of high speed steel are limited to a certain point, that point being where a fractional quantity of material must be left, and extreme care exercised in arriving at the precise dimensions. For this final finishing I claim that the grinding machine is the most rapid and economical tool to use, for the following reasons: It removes this fractional amount of material in the shortest comparative time; it arrives at the desired dimensions by a series of rapid and minute chips which cover the whole surface repeatedly, and whose depth is under perfect control; any variation in its shower of sparks is instant and visible evidence of its change of form, either through distortion or accident; and, finally, it allows of the actual surface finisning being the last operation, thereby removing all those errors and distortions which are a result of keywaying or other operations. To those who are not conversant with the more modern development of the grinding machine, the first of these reasons may appear an exaggeration; but an inquiry into what is being done in the matter at the present time will only serve to substantiate the statement. For the correcting of hardened work it has long been considered a necessary part of the engineer's equipment, but its use for general finishing purposes has been, and is still, considered by many to be indulging in a luxury.

As instances of the amount of stock which may be removed by a modern grinding machine, I may quote the following examples of work done: Several cast-steel bars, 10 feet in length and 1 15/16 inch in diameter, were reduced 0.080 inch in an average time of 75 minutes, the greatest variation in diameter being 0.0004 inch. A chilled-iron roll, 4 feet long and 17 inches in diameter, was reduced 5/16 inch in diameter in 7 hours. A cast iron roll, 4 feet by 6 1/16 inches, was reduced 1/16 inch in diameter in 25 minutes, the greatest variation being 0.0005 inch. These examples will convey some idea of the amount of material which may be removed in a given time by a grinding wheel; and in the first two examples it was found more economical to grind outright from the rough black bar and casting than to turn and grind. I find the leaving of a grinding allowance of 0.015 inch to 0.030 inch on the diameter to be the most economical for general work. These broad limits allow the lathe hand to use coarse feeds and work rapidly. In order to keep within these limits, rough tolerance gages are desirable, for if the maximum amount given be exceeded, waste of both grinder's time and abrasive material must ensue. The fact that a ground surface is superior to that produced by a file or water-cut is indisputable, and the rapid manner in which a fixed dimension may be obtained is a further recommendation; that the result is effected by a series of minute chips with a visible index of their depth is another point in its favor. In order to start a finishing cut in the lathe and control its size, the length of its traverse requires a sense of touch which may have taken years to attain; to obtain a similar result, but a better surface in the grinding machine, is an easier matter, because another sense is enlisted, and the work is simplified. Given a few days' practice with a grinding-machine, an operator can judge to 0.001 inch the depth of the cut he is taking, by the shower of sparks displayed. In actual practice, where accurate results are necessary, the following points must receive attention. The first in importance is that there must be an abundant supply of water delivered at the grinding

point. Secondly, hard bonded wheels should be avoided, as they do not cut freely, and may well be compared to a dull milling cutter; they are mostly chosen through mistaken ideas of economy.

Where a high degree of surface finish is required for appearance only, the grinding machine is superior to hand labor, for various reasons; it is more rapidly done, and leaves a surface more uniform and pleasing to the eye. This latter recommendation may seem a trivial one if we fail to remember that this method of finishing secures the most accurate results; it yields cylindrical work which is both truly round and concentric with the center points on which it is held, and this is always an advantage. Again, in the finishing of plane surfaces the easiest method of holding the work to the machine table is that which will give the most precise results; thus a slide or similar body would be outwardly finished by clamping its scraped and finished ways to packings ground in position. This insures absolute truth of outer alignment, which would be of great value to the operator of the future built-up machine, and its beauty of finish would probably be a means of insuring his care that its accurate condition be maintained. The great advance that has been made in grinding practice recently has been mostly in work of cylindrical form, and for this purpose its claims to attention are undeniable. Personally, I see no reason why the same advantages cannot be obtained in the grinding of plane surfaces with a suitably designed machine.



Pneumatic Tube and Pipe Cutter.

PNEUMATIC TUBE AND PIPE CUTTER.

Railroad Gazette, August 2, 1907.

A pneumatic tube and pipe cutter of interesting design is used in the shops of the Seaboard Air Line at Portsmouth, Va. This machine can be easily operated by one man, and can cut three two-inch locomotive tubes per minute with an air pressure of 50 pounds per square inch. If the air pressure is increased, the machine will perform its work even more rapidly.

The machine consists of a sleeve *A* turning in long bearings and driven by a pulley keyed near its center. At the end of the sleeve is an enlargement containing three cylinders to which pistons are fitted. These cylinders stand on radial lines and the pistons have roller cutters attached. There are ports through the sleeve, as shown, that lead to the outer end of the cylinders, through which air is admitted by means of a three-way cock. Stops for the tube and Y-supports are provided beyond the end of the machine. After the machine is started the tube is placed in position to be cut, resting on the supports and shoved back against the stop. It is clamped by pressure on the pedal shown, and the handle of the three-way cock is turned to admit air to the outer ends of the cylinders. This forces the pistons in and the cutters against the tube. As the circular head revolves the cutters roll around the tube and are forced in, and cut off the piece in a few revolutions.

The piece cut off passes out at the back end through the hollow tapered spindle. When the tube is cut, the air valve is moved to exhaust, and the cutters open by centrifugal force to receive another tube. As the tube is clamped by the pedal it can be fixed and released instantly without loss of time, and as the tube does not revolve, the machine is practically noiseless. In addition to these advantages the boiler maker does not have to mark each tube where it is to be cut, as the length is fixed by the adjustment of the stop. The cutters are of steel, ⅛ inch thick and 3 inches in diameter. One set of cutters in the Seaboard Air Line shops has been in service for four months and has made 24,000 cuts, without grinding, on 2-inch tubes, approximately ⅛ inch thick. Previous to building this machine, the number of engines that could be turned out of the shop was dependent on the tube work; but since its installation the amount of tube work to be done is not considered in deciding upon the number of engines to be turned out.

PREPARATION OF ENGINEERING ARTICLES AND TECHNICAL PAPERS.

Proceedings, American Society of Mechanical Engineers, October, 1906.

In preparing an article for publication, or for presentation before a professional society, there are some general principles, the observance of which will add greatly to the value of the work. These principles do not relate to the subject matter directly, but rather to the manner of presentation. In the first place, as a paper generally does relate to some especial department of work with which the author has had experience, he is very apt to assume many things as matters of common knowledge, when in fact they are not nearly so familiar to most of the readers as they are to himself. It is not usually a mistake to be too clear, or too definite, particularly in the preliminary statements. If, therefore, the author avoids undue assumptions as to the familiarity of his readers with the subject in hand he will add greatly to the value of his statements. The rules to follow for the presentation of the subject itself may then be given as follows:

State first, in a brief and clear manner, just what the article is about, what the author is endeavoring to show, or what he expects to prove. This introductory statement should be *very brief*, and having been made, it should be kept in mind throughout. A paper should be about but one thing at a time, and that one thing plainly stated at the start.

Then should follow the general treatment; description of work, of experiments, of opinion, etc., this portion constituting the matter usually forming the body of tecnnical articles or papers.

After this should come what may be called "proof," that is, a statement showing how the general matter immediately preceding has demonstrated what the author set out to show.

Finally there should come a very condensed summing up, in such a form that a brief glance would enable a casual reader to grasp the substance of the article, and decide without reading the whole, whether or not he wants to examine it in detail.

The introductory statement, and the final conclusions, should in every case, enable the reader to get at the kernel of the whole matter, of which the bulk of the article should be the detailed and expanded treatment.

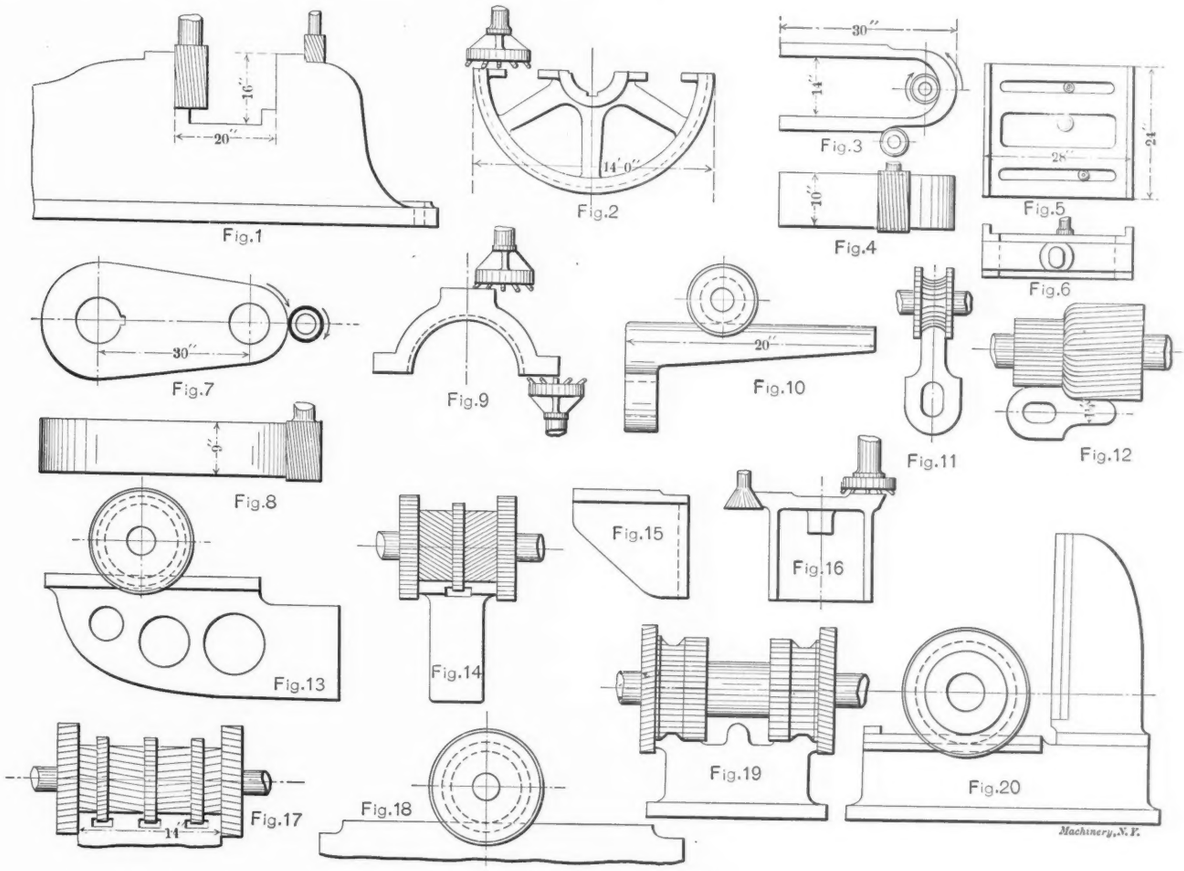
The following rules should be adhered to in regard to the mere mechanical preparation of copy for publication. Write plainly, on one side of the paper. Number the sheets consecutively in the upper right-hand corner, and have them of a uniform size. Put full name and address on all manuscripts. All sketches, drawings and tables should be made on separate sheets of paper. In selecting photographs or making photographic prints for illustrations, it should be remembered that the glossy solio prints are better suited for reproduction than velox, or other matted surface paper; besides, they bring out all the detail in the negative to the best advantage. Photographs should not be printed too deep, and the reproductions are better made from prints of a slightly reddish tone than from those over-toned to a bluish tint.

All copy intended for illustrations should be clearly marked with the title, subject and author's name, a reference to the manuscript to which it relates, and all other data of interest. This had better be written on the back in pencil; ink is apt to show through, especially when written on the back of light portions of a photograph. If the illustrations be many, a list of them, giving their titles in brief, should properly accompany the manuscript.

THE RELATIVE VALUE OF MILLING AND PLANING.

Walter Duckitt, in *The Engineering Review*, July, 1907.

The relative merits of milling and planing processes is a subject which has received the attention of some of our most capable engineers and machine tool builders during the past few years. Speaking broadly on the question, it must be admitted that the field of operation of the planer is comparatively small compared with that of the miller, the latter machine having developed, during recent years, to such an extent as to bring it into the front rank of machine tools, and to render it an indispensable acquisition to the shops. It has by no means, however, displaced its older rival, the planing machine, which has to be considered in its redesigned and appropriately named "high speed" type. One of the chief and most advantageous features of the planing machine is the comparative cheapness of its cutting tools and general equipment, as compared with those required for its more modern competitor, the miller. The former, when belted up, can generally be set to work at once, as



Examples of Milling Operations.

any tool smith can easily forge the general run of cutting tools that are required, whereas, in the case of the miller, a large equipment of cutters and fixtures is required, sometimes amounting in value to a thousand dollars or more.

The milling machine, therefore, in some respects, is at a disadvantage as compared with the planer, namely, that whereas the former requires a good tool-room to keep its equipment in thorough order, a tool smith and a simple grinder suffice for the latter. Even with this to be said in favor of the planer, however, it must not be taken that it scores as heavily as at first appears in the matter of cost of equipment, as most of the leading brands of high speed cutting steel now on the market are very expensive, and in a full set of tools for a planer, therefore, there is a large amount of capital sunk in the weight of steel alone, to say nothing of the labor.

Milling machines which enter the field of competition with the planer may be classified under vertical and horizontal types. Of the horizontal spindle type there is the small hand

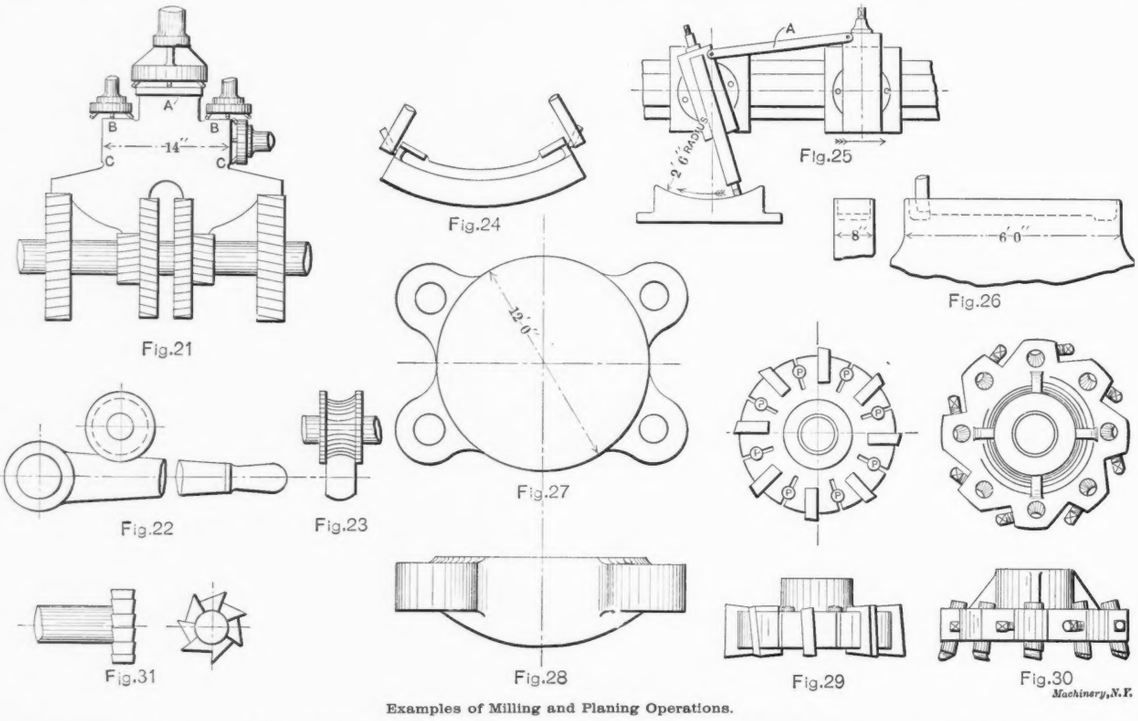
feed class, which can scarcely be said to come into actual competition with the planer, except for milling keyways into shafts, spindles, etc., which, if of any length, was formerly done entirely on planers. For keyway cutting, the milling machine may fairly claim to have scored heavily, and of late years has taken this class of work entirely off the planers, as with the latter machine a highly skilled man is required to cut the keyway to its proper dimensions, whereas with a miller, all that is required is a simple keyway cutter of the required width, and the only dimension the operator has to watch is the depth. A comparatively unskilled, and, therefore, much lower rated man can accomplish this.

Coming to the Lincoln type of miller, this machine is chiefly used for manufacturing operations of the medium and light trades, such as automobiles, small arms, sewing machines and bicycles; indeed, it is in a great measure due to this type of machine that these trades have developed to their present magnitude, enabling the various small operations to be performed by cheap labor by the aid of jigs and fixtures, coupled, of course, with good supervision. A very large variety of operations can be performed on the Lincoln miller for a mere fraction of the cost that would be involved were a planer used.

correct radius as shown. These levers are milled on both edges in exactly fifteen minutes each, at a cutting speed of 46 feet per minute, and a table feed of 3 inches per minute. Of course there is not much to remove, but it would take a planer at least one and one-half hours to perform the same piece of work to a very indifferent finish.

Figs. 17 and 18 show a gang of cutters operating on a plain milling machine table. The two outside cutters finish the table to width, the four small cutters operate on the top of the table, while the three narrow cutters finish the T-slots to width, leaving them to be finished with the T-slot cutter, Fig. 31, on a vertical machine. The gang cutters when not used for the job, are stored away complete with their arbor, because, if used singly on general work, they would lose their size, owing to the necessity for constant grinding and re-sharpening. This is a very important item with expensive gang cutters, which should be borne in mind. It formerly took twelve and one-half hours to plane up this table; it is now milled in four hours at a cutting speed of 35 feet per minute and a table feed of 1¼ inch for the roughing and 1¾ inch for the finishing cut.

Figs. 13 and 14 show a planer housing arranged to be gang milled on the face on a heavy horizontal slab miller of



Examples of Milling and Planing Operations.

We then come to the upright plain miller with overhanging arm for support to the cutter arbor and adjustable knee or table support. These machines are adaptable to a wide range of work to which the planer formerly claimed a monopoly, effecting, in the majority of cases where they are employed, a very considerable economy.

Examples of Saving Afforded by Milling.

A very good example and typical piece of work suitable for either the Lincoln or upright plain types is the forged steel cotter shown in Figs. 10, 11 and 12. Machined all over for the connecting-rod ends of a large stationary Corliss engine, this is a difficult piece of work to perform on the planer, due to so many curved surfaces and radius corners for forming the head. It formerly took nine hours to plane, and then only resulted in a very imperfect job, necessitating several hours filing and fitting to finish it. A boy now completes it in a miller in 4¼ hours, representing a clear saving in labor cost of over 250 per cent. Another example of milling suitable for the Lincoln and upright plain type of machine is the brake lever for an automobile shown in Figs. 22 and 23. This is a mild steel stamping, with round edges, 2 feet 6 inches long, formed with a simple form cutter of the

the Ingersoll and Newton types, at a table feed of 2½ inches per minute. This is done with about 60 per cent economy, as compared with the planer. Figs. 19 and 20 show a very excellent piece of work done on a heavy slab miller. The work is a bed for a gear hobbing machine, only four cutters being required for the operation, including the finishing of the sliding ways for the table on each side. These ways are completed with the two form cutters shown, spaced the exact distance apart, which is a very vital point, and saves a lot of bedding when fitting the table. The latter is also gang milled, with suitable cutters, to fit on the ways. The housing shown in Fig. 20, and also the head for carrying the cutter spindle, are milled in a similar manner. Fig. 1 shows the crank-shaft end of a large stationary engine bed, the adjustable bearing gap being milled out to size by a large and extremely powerful machine of the milling and boring type. The cutter is fed to the work, the latter remaining stationary; the bed end is milled complete for the bearing and cap in ten and one-half hours, a performance that would be very difficult to duplicate on a planing machine, however powerful.

Fig. 2 shows part of a large rope driving fly-wheel, cast in halves, being milled across the joint in the same machine with an inserted tooth cutter. In this case also a great

saving is effected as compared with the planer. The latter machine has to travel across the entire face, and thus fully 75 per cent of the stroke is wasted, as reversals and very short strokes on heavy planers are not to be recommended; whereas with the miller, only the surfaces actually operated on are traversed. The keyways are also cut at the same time with an end milling cutter the same diameter as the width of key, and thus much time is saved in that direction also. Fig. 9 shows an eccentric strap being milled in the same manner, at a great saving compared with planing.

The vertical spindle miller has been developed to include a large field of operations from keyway cutting up to work of very large dimensions. Figs. 3 and 4 show a large forged steel strap for a connecting-rod, milled all over on a vertical spindle machine. The top and bottom are milled first with inserted tooth cutters, the strap being then finished inside and out, in the manner shown, at a cutting speed of 45 feet per minute and a feed of 2 inches per minute. The time taken is now twenty-one hours, whereas formerly, to plane and slot these straps took twenty-nine hours. Figs. 5 and 6 show a large double-ported slide valve, the ports of which are milled to size in a vertical spindle machine, after the valve has been planed all over, on a high speed planer, cutting at 35 feet per minute. This is an instance where both the planer and the miller can be used to advantage on the same piece of work for different operations, as it has been found that, excepting the port holes, these pieces can be planed cheaper than milled.

Figs. 7 and 8 show two large steam engine cranks of forged steel, planed top and bottom, and then finished all round on a large vertical spindle machine with a circular milling attachment. This machine has two spindles, the crank shaft and pin holes being bored both at the same time after the milling is completed, thus saving the time of extra handling, no small item where heavy weights are involved. Figs. 15 and 16 show a knee or table support for a milling machine, being milled on a vertical spindle machine, the angular cutter operating on the sides as shown. In Fig. 21 one of the most remarkable examples of milling is shown. It consists of an aluminum crank case for a 30 H.P. motor car engine, 2 feet 6 inches long. The top face marked *A* is first milled, the faces *B* being operated on at the same setting. The surface *A* is then bolted against an angle plate, and the cam shaft cover faces *C* are completed. The cutting speed is 580 feet per minute, and the feed 10½ inches per minute. The case is then taken to the slab miller, and the bottom milled out complete with gang cutters as shown. These engine cases, which formerly took twelve hours to plane, are now milled in 5 hours. The milling machine is far better adapted for working aluminium than the planer, because of its having a much wider range of speeds and feeds.

The universal milling machine can fairly claim to be the king of millers, if, indeed, not of all machine tools, but being chiefly designed for tool-room work, it can scarcely be said to enter the field of competition with the planer. American tool makers, especially, have paid particular attention to this type of machine, and it is chiefly due to their efforts that it has reached its present high state of perfection.

Examples of Work More Advantageously Planed than Milled.

The design of the planer has, however, been much modified during the past few years, chiefly due to the advent of high speed steel. Whereas a few years ago it was considered good standard practice to work at a cutting speed of 20 feet per minute, and return at 40 feet, it is now no uncommon thing to see planers cutting at 40 feet, and in some cases 50 feet per minute, and returning at 200 feet per minute. Machines of this type can, on certain work, hold their own against the milling machine, and on this account will continue to keep up their established position in the shops. More particularly does this apply to the heavier branches; for instance, an example is shown in Fig. 24, which represents a segment of a large rope-driving fly-wheel rim being operated on at both ends at the same time by two saddles on the cross-slide. Eight of these segments—sufficient to build a wheel—are placed in a row on the machine table, being thus planed all at one setting, thereby ensuring extreme accuracy, cutting at 25 feet per minute and returning at 50 feet, using high speed tools. This is a very heavy piece of work which no milling machine could perform in the time taken to plane them. Fig. 25 shows a very interesting piece of work in the shape of a former plate, 10 feet 6 inches long, for a vertical plate bending machine, being planed out to a radius of 2 feet 6 inches in the manner shown. The left-hand tool box is set centrally above the work and the swivel head-bolts slacked; the saddle is then locked in position, and the rectangular bar, *A*, is connected to both the tool boxes. The right-hand tool box then commences to travel in the direction shown by the arrow, and by so doing drags the cutting-tool through the required arc. This is a job which no milling machine could accomplish satisfactorily with such primitive equipment.

Fig. 26 shows the slides of a horizontal engine which are planed to advantage, as milling cutters cannot be got in at the end, owing to insufficient clearance. Figs. 27 and 28 show a large hydraulic press top cover weighing 50 tons, which is planed on a large machine operating four cutting tools at the same time, two in each tool box on the saddle. There has not yet been found a quicker method. The concluding sketches, Figs. 29 and 30, show two types of inserted milling cutters for use on heavy milling machines. Fig. 29 is a type largely used on vertical spindle machines; the cutters are given 5 deg. forward rake, and are held in position by the taper pegs, *P*, driven into holes, which are gashed through with a slitting saw as shown, to give the necessary spring under the wedging action. This cutter gives good results, if ground accurately, on certain classes of work, but is more expensive to make than that shown in Fig. 30, which has simply round cutters secured by screws. The holes for carrying the cutters are not bored with any forward rake, that being ground on the cutter itself. This type of cutter is largely used on heavy rough work and also in smaller sizes on aluminum, where it scores heavily over the flat-tooth variety. The latter is not designed to allow of sufficient clearance on the bottom which is absolutely necessary on aluminum, otherwise the chips get under the cutters and produce a very rough finish on the work.

Weighing the profit-earning qualities of the planing and milling machines, it is generally conceded that the miller predominates, but at the same time, the planer still leads, on certain classes of work, such as long straight surfaces, plate edge planing, and lathe-bed planing, more particularly on the larger sizes, also planing the slides of their own beds, as well as tables, etc. It may safely be concluded that although the milling machine is pre-eminent, the planer will always find favor on certain classes of work.

* * *

MEASURING SCREW THREAD DIAMETERS.

WALTER CANTELO.*

It is always advisable when measuring screw thread diameters to measure them in the angle, in addition to testing their diameter on top of the threads and at the bottom of the thread groove, but unless calipers made expressly for the work are at hand, the measurement in the thread angle is apt to be omitted. The tables in the supplement were worked out by the writer in 1902 for convenient application in the inspection of screw threads in connection with ordnance inspection for the United States army. The method is known as the three-wire system of screw measurement, because three wires, of the diameter called for in tables, and applied as shown in the diagrams in the supplement, are used in connection with an ordinary flat point micrometer. The dimensions for the standard threads of the systems shown are given in the tables mentioned. For threads of special size or pitch, the values for the various thread parts are easily computed from the formulas given for the kind of thread under consideration. It is especially necessary that the wires used be as nearly round in section as possible, and of uniform diameter.

Two methods of measuring are shown for the 60-degree V, U. S. standard and Whitworth threads, and for each method a formula and table of values are given. The three-wire method

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is preferred by the writer, because the error in the thread groove—if any be present—is taken into consideration twice, while by the single-wire method errors are liable to be introduced by the surface on top of the threads not being exactly concentric with the thread groove. It is evident that for each of the threads the wire to be used in any thread groove is limited in regard to diameters as follows:

The 60 Degree V Thread.

Maximum diameter of wire $= \frac{p}{0.866} = 1.155\,p$, if p equals the pitch of the thread.

Minimum diameter of wire $= 0.577\,p$.

The U. S. Standard Thread.

Maximum width of thread groove $= \frac{7}{8}\,p$.

Maximum diameter of wire $= \frac{7}{8} \times \frac{p}{0.866} = 1.010\,p$.

Minimum diameter of wire $= \frac{7}{8} \times 0.577\,p = 0.505\,p$.

The 55 Degree Whitworth Thread.

Let p_1 = distance across thread groove at point where radii are tangent to angle.

Radius on thread $= 0.1373\,p$, and arc forming top of threads contains 125 degrees.

Then $p_1 = p - 2 \sin 62° 30' \times 0.1373\,p = p - 2 \times 0.887 \times 0.1373\,p = p - 0.243\,p = 0.75\,p$, approx.

Maximum diameter of wire $= 0.75 \times \frac{p}{0.887} = 0.84\,p$.

Minimum diameter of wire $= 5/6 \times 0.6068\,p = 0.505\,p$.

The dimension D_1 (see diagram in supplement) has to be considered for both the single-wire and three-wire methods and has values as follows:

For the 60 deg. thread: The depth equals $0.866\,p$ and as the apex of the thread angle and root of thread groove are at the same point, it follows that $D_1 = D - 0.886\,p \times 2 = D - 1.732\,p$ or $= D - \frac{1.732}{n}$.

For the U. S. Standard thread: The depth equals 6/8 of the 60 deg. V thread, being flattened on top and filled in at the root an amount equaling one-eighth of the V thread depth and the distance from the top of thread to apex of thread angle at root, therefore, equals $\frac{7}{8}$ of the V thread depth, or $\frac{7}{8} \times 0.866\,p$ and $D_1 = D - \frac{7}{8} \times 0.866\,p \times 2 = D - 1.5155\,p$ or $= D - \frac{1.5155}{n}$

For the Whitworth 55 deg. thread: The depth equals 4/6 of the 55 deg. V thread depth, being filled in at the root and cut away on top an amount equaling 1/6 of the V thread depth. The depth of the 55 deg. V thread would be $0.96045\,p$ and the distance from top of Whitworth thread to apex of thread angle at root equals $5/6 \times 0.96045\,p$ or $0.8004\,p$ and $D_1 = D - 2 \times 0.8004\,p, = D - 1.6008\,p$, or $= D - \frac{1.6008}{n}$.

From the foregoing it will be seen how the formulas $x = D_2 + 2b + a$ for the three-wire system, and $x_1 = \frac{D}{2} + \frac{D_2}{2} + b + 2a$ for the single-wire system are produced, and also, it will be readily seen how easily the formulas $x = D - \frac{1.732}{n} + 3\,a$ for the 60 deg. V thread and $x = D - \frac{1.5155}{n} + 3\,a$ for the U. S. Standard thread, as given in the article by E. A. Johnson in the January, 1907, issue of MACHINERY, may be arrived at.

The Acme 29 Degree Screw Thread.

For this thread I prefer to use a separate wire for each pitch, of such diameter that when laid in the thread groove of the tap or thread plug gage, it will be flush with the tops of the threads when they are of correct dimensions, and when laid in the thread groove of the screw it will extend 0.010 inch beyond the tops of the threads.

The Brown & Sharpe 29 Degree Worm Thread.

For this thread also I prefer to use a separate wire for each pitch that will be flush with the tops of the threads when laid in the finished thread groove.

NICKEL STEEL.*

E. F. LAKE.†

Nickel steel is used to a large extent in the construction of high-grade machinery, and can be purchased in the open market, to-day, in almost any percentages of nickel from nothing up to 35 per cent, and with the carbon component varying between 0.10 and 1.00 per cent. Thus it covers a wide field of usefulness in which greater strength, wearing qualities and other properties are demanded, than can be obtained in the ordinary carbon steels.

Nickel Prevents "Sudden Rupture."

Nickel was added to carbon steel as the result of investigations which were started for the purpose of overcoming the "sudden rupture" that is inherent in all carbon steel product. This property or tendency of carbon steel to rupture is the subject of numerous investigations by the railroads of the country at the present time, owing to the many accidents that have occurred in the past few years being blamed to broken rails. Nickel added to steel largely overcomes this tendency, and we see it used successfully for parts of machinery that have to withstand high shock and torsional tests, such as the crank-shafts and connecting-rods of explosive

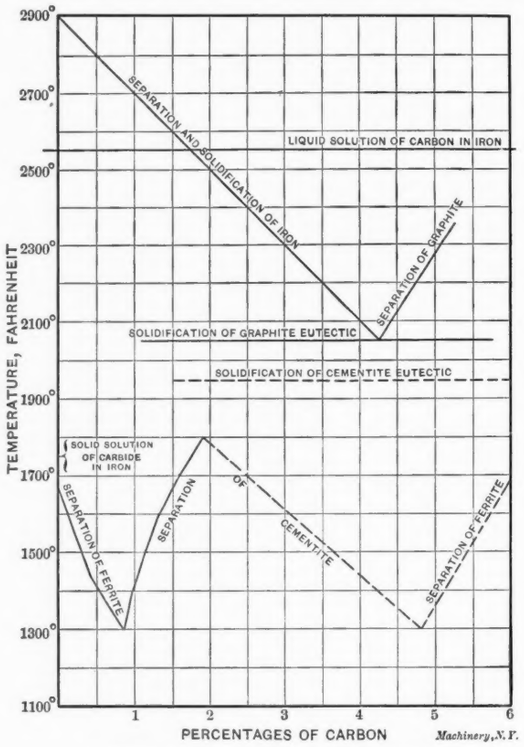

Diagram of Characteristics of Nickel Steel.

engines, propeller shafts for marine and automobile use, and other parts of a similar nature which have to withstand similar strains and stresses.

Effect of Nickel, Not Uniform.

Nickel gives to steel one peculiar property, in that it can be added in percentages up to 8, and the tensile strength and elastic limit will be raised by so doing, but in percentages from 8 to 15 these become nil, as a zone of brittleness is produced and no tests can be applied, but at 16 per cent the strength and elastic limit are returned, and from there on these gradually decrease, while the extensibility increases.

Beneficial Effects of Nickel in Heat Treatment.

The qualities of carbon steel are susceptible of change by heat treatment the same as alloy steels, but the higher the carbon content is, the more liable it is to burn and thereby reduce its strength, and it is extremely difficult to case-harden steels which contain more carbon than does mild steel with-

* For additional information regarding the manufacture and characteristics of this and kindred steels, see the article in the July, 1907, issue of MACHINERY: Nickel-Chrome Steel, and previous articles referred to in the same issue.

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out destroying their good qualities and strengths. By the addition of nickel the tendency to burn is largely overcome, and the extent to which it can be swayed by heat treatment is remarkable. This is best illustrated by Table I in which the steel was given different degrees of hardness. Its composition was as follows:

Nickel, 3 per cent; carbon, 0.30 per cent; manganese, 0.40 per cent; phosphorus, 0.05 per cent; sulphur, 0.04 per cent.

TABLE I. STRENGTH OF NICKEL STEEL AT DIFFERENT DEGREES OF HARDNESS.

Hardness.	Tensile Strength, pounds per sq. in.	Elastic Limit, pounds per sq. in.	Elongation in 2 inches, per cent.	Reduction of Area, per cent.
Annealed.....	88,000	60,000	28	58
Medium Hard	130,000	130,000	20	6
Hard.....	220,000	190,000	12	37
Very Hard	225,000	225,500	8	19

A good quality, open-hearth, 0.30 per cent carbon steel, as received from the mill in the untreated state, shows the same strength as the untreated nickel steel in Table I, but it cannot be raised to much more than one-half of the strength of the nickel steel in its hardest state, and even then it is much more liable to fracture under shock tests.

What the Microscope Reveals in Testing Steels.

Steel subjected to different heat treatments shows different properties when examined under a microscope, and microscopy is becoming one of the methods of examining and testing different steels. If we take a piece of steel containing less than 0.85 per cent of carbon, polish it, attack it with a few drops of picric acid and examine it under a microscope, the results will be widely different according to its composition and the treatment it has undergone. In a piece of steel that has been cooled slowly, small dark masses will appear which are more numerous the closer the carbon is to 0.85 per cent, and for this percentage the small dark masses occupy the entire surface with alternate layers which are iron—called ferrite—the dark masses being called cementite, they being an iron carbide. When nickel is added to carbon steel, this latter element has the appearance of mother-of-pearl, and is called pearlite.

Nickel steel containing less than 0.85 per cent carbon is, therefore, composed of ferrite and pearlite, and the proportion of the former grows smaller as the carbon content is reduced. If the steel contains more than 0.85 per cent carbon it will show, and is composed of pearlite and cementite, and the cementite increases as the carbon content is raised. These pearlitic steels may also contain chromium and manganese.

Next heat this steel to 1,400 degrees F., or a dull red, and quench in water, then polish, attack with picric acid, examine under the microscope as before, and it will show extremely fine lines intersecting each other in the direction of the sides of an equilateral triangle. This constituent is called martensite, and is found in all carbon steels quenched in an active bath after heating to the above degrees.

If the temperature is increased to 2,200 degrees F., or a bright orange, and the steel quenched in a very cold bath, as, for instance, one that is made 32 degrees F., by a salt-and-ice solution, there appears, in addition to martensite, another component called austenite, and this is easily scratched with a needle.

Then if the steel is quenched, during its transformation or above this point, in an oil bath, or one of little activity, a component is obtained that appears jet black, and is very easily colored with picric acid. This is known as troostite.

Therefore by annealing or heating and quenching this steel we can change its components from troostite to austenite, martensite, or pearlite, or *vice versa*, and its condition is readily determined by the aid of a powerful microscope.

If we take a large piece of steel in which a microscopical examination always indicates martensite to be present in the surface layer, different constituents will be shown at a certain distance beneath the surface and often very close to it. These constituents are only slightly colored by picric acid and are known as troostite and sorbite. In this case the transformation is not as complete as in the small piece, and there has been a sort of partial return to the normal state.

Other Effects of Heat Treatment.

Other molecular changes take place in heat treating steels and some of these are governed by the carbon contents. These changes are shown by the accompanying diagram.

If certain steels are given the heat treatments as described above, the average blacksmith would try them with a file, and if the file bites as well as it did before heat treating he would throw the steel out as not hardened, yet transformations have taken place which would show by tests that the tensile strength and elastic limit have been raised while the elongation and reduction of area were reduced. In the case of the nickel steel of which Table I shows the test, these transformations have been given a range for strength—*i. e.*, from 88,000 pounds to 225,000 pounds per square inch—that would have been considered impossible a few years ago.

Thus annealing, hardening and tempering steel are resorted to for raising the tensile strength, elastic limit, and its ability to withstand shock and torsional tests, as well as to put a fine cutting edge on tool steels. For another example of this, a nickel steel containing silicon was heat treated as shown in Table II, and with the resultant strengths as shown.

Need for Annealing.

In heating treating steels for strength, and especially nickel steel, it should always be remembered that hardening by quenching produces internal strains which can only be removed or destroyed by tempering or drawing after it is quenched. Thus nickel steel cannot be used in its hardest state, and in which it has the highest tensile strength and elastic limit, for crank-shafts, connecting-rods or other parts of machinery that have to withstand similar strains and stresses, but the piece must be tempered, thereby reducing the strengths and increasing the elongation in order to reduce the brittleness as well as the internal strains caused by hardening. These internal strains may also be caused by forging, hammering, or working, and the best results will be obtained if the steel is annealed after each important operation.

Liability of Nickel Steel to Warp, Decarbonize and Crack.

Three things work to the detriment of nickel steel and should always be taken into consideration when hardening it. First it nearly always warps in quenching; second, it may be decarbonized in heating; and third, fissures and cracks might occur in quenching.

TABLE II. EFFECT OF HEAT TREATMENT ON NICKEL STEEL OF THE FOLLOWING COMPOSITION:

Nickel, 2.51 per cent; Silicon, 0.26 per cent; Carbon, 0.33 per cent; Manganese, 0.43 per cent; Phosphorus, 0.023 per cent; Sulphur, 0.032 per cent.

Treatment.	Tensile Strength, pounds per sq. in.	Elastic Limit, pounds per sq. in.	Elongation in 2 inches, per cent.
Quenched at 1600° F.....	225,000	208,000	4
" " " tempered at 600°.	215,000	201,000	6
" " " " " 800°.	190,000	150,000	9
" " " " "1000°.	170,000	145,000	12
" " " " "1200°.	155,000	125,000	14
" " " " "1400°.	135,000	98,000	17
" " " " "1600°.	104,000	65,000	24

There are several rules which can be followed to minimize the tendency of steel to warp in quenching. If a piece is cut from stock that has been subjected to some mechanical treatment, it is very liable to be deformed on being heated, and it is undeniable that of the deformations attributed to the hardening process, a large part is due to the heating which precedes quenching, and results from the use of metal which has been mechanically worked. To overcome this, the steel should be thoroughly annealed before it is machined to size, so that the metal will be in a state of repose, and even then the tools used in machining may cause depressions in the metal that will cause warping when it is hardened.

In quenching, the piece should be immersed in the bath in the direction of its principal axis of symmetry, so that the

liquid can cover the greatest possible surface, and it should never be thrown into the bath. Thus a shaft should be immersed vertically and a gear wheel perpendicular to its plane. The piece should also be agitated in the bath so as to destroy the coating of vapor which usually forms around the piece and prevents its cooling rapidly.

To reduce the tendency to decarbonize, it is necessary to provide against oxidation, therefore the atmosphere within the furnace must be kept as far as possible reducing, and the pieces must be prevented from coming in contact with the gases.

This can be done by placing the pieces in a protecting retort, or in using a metallic heating bath, such as one of lead.

Fissures or cracks which occur in hardening are caused by the different parts of the piece cooling unevenly, thus producing internal stresses of enormous proportions which sometimes produce brittleness and consequently fissures or cracks, as nickel ferrites have a lower degree of molecular cohesion than plain ferrites. These fissures may be prevented, by reducing the rate of cooling, in three different ways. One method is to cover water with oil from one inch to one inch and a quarter in depth. The second is to cool the pieces in a bath of a comparatively limited volume, so that the cooling is followed by a slight tempering, and the third is to withdraw the piece from the bath before it is completely cooled. This last requires considerable skill to obtain uniform results.

Nickel Steel Well Adapted for Gears.

Nickel steel is one of the best steels on the market for gears, when carbonized, as different tests have shown that 2 per cent of nickel added to the ordinary carbonizing steel will double, and in some cases more than double, the tensile strength after carbonizing, and these tests would prove that nickel steel should be used for carbonizing wherever the difference in price will warrant. It is from 2 to 2½ cents per pound higher than the ordinary carbonizing steel, but the greater safety in manufacturing, and a consequent decrease in the number of spoiled pieces, will largely overcome this difference in price.

If a 2 per cent nickel steel is carbonized so the surface layer contains 1 per cent of carbon, it will show pearlitic, when examined, but if a 7 per cent nickel steel is used it will show a surface layer that is martensitic with a core pearlitic, or, in other words, the periphery has the same constitution as if it had been quenched and nardened while the core was in the annealed state.

The different materials used in carbonizing have different effects as to the penetration of the carbon and the time required for a certain penetration.

But a general rule for the rate of penetration at different degrees of temperature is as follows, the time being eight hours:

F., Degrees of Temperature.	Depth of Penetration.
1,300	0.000 inch.
1,475	0.0195 "
1,565	0.039 "
1,650	0.0625 "
1,700	0.08 "
1,750	0.110 "
1,800	0.125 "
1,850	0.165 "
1,900	0.195 "

Thus it will be seen that a rise in temperature of 150 degrees doubles the rate of penetration, and in one case a rise of 90 degrees has doubled it.

With the temperature held stationary at 1,850 degrees the speed of penetration is as follows:

Time.	Depth of Penetration.
¼ hour	.....
½ "	0.02 inch.
1 "	0.31 "
2 "	0.40 "
4 "	0.50 "
6 "	0.80 "
8 "	1.20 "

The steel used for carbonizing should not contain over 0.2 per cent of carbon, and the manganese component should be low, as this has a tendency to produce crystallization in annealing, and cause brittleness.

The cement used should be of a definite chemical composition which does not act abruptly, such as 60 per cent powdered charcoal and 40 per cent carbonate of barium, and two rules might be followed in treating; one being to carbonize at 1,600 degrees F., cool to 1,400 degrees, and quench; and the other is to carbonize at 1,850 degrees, quench first at 1,650 degrees, and the second time at 1,400 degrees.

Nickel Steel Not of as High Grade as Nickel-chrome Steel.

Nickel steel is not of as high a grade as nickel-chrome steel or the newer vanadium steel, but it stands a good second to these, is about two-thirds the price, and is so much easier machined and forged than nickel-chrome steel that it is used in preference to the higher grades.

Care Required in Forging and Working.

In forging, great care must be taken to keep this steel at a high full forging heat and never hammer or roll it below this temperature, as cracks are then liable to occur. A great deal of talk is heard among the users of nickel steel about its cracking badly and being defective, and if defects occur in the bloom, they are pretty sure to show up somewhere in the finished product, but if the steel is properly rolled and forged these defects and cracks will not appear. Where carbon steel has been used for automobile axles and given way from fatigue, crystallization or other causes, heat-treated nickel steel has been substituted, and has given perfect satisfaction.

TABLE III. INFLUENCE OF DIFFERENT PERCENTAGES OF NICKEL IN NICKEL STEEL.

Per cent of Nickel.	Tensile Strength, pounds per sq. in.	Elastic Limit, pounds per sq. in.	Elongation in 4.72 in. per cent.	Treatment.
1 to 1½	78,000	48,000	18	water tempered at 1650° F.
2½ to 3½	97,000	82,500	15	medium hard.
2½ to 3½	80,000	68,000	20	" soft.
2½ to 3½	85,000	60,000	23 to 13	" hard, structural.
2½ to 3½	71,000	50,000	28 to 16	" so t, "
4½ to 6	102,000	74,000	15	hard, for strenuous work.
4½ to 6	121,000	107,000	12	" but annealed at 1600° F.
4½ to 6	88,000	63,000	20	medium hard
16 to 18	199,000	114,000	6	annealed at 1650°.
22 to 26	110,000	45,000	40	" " "
22 to 26	114,000	50,000	35	" " "
30	80,000	28,000	44	" " "

Proportion of Carbon Important.

We frequently hear the boast of different manufacturers that they use 2 per cent nickel steel for various parts of their machines, but this means nothing, as its properties depend as much upon the carbon content as on the nickel. To illustrate, one nickel steel that is largely used, and is the best for certain purposes, contains 2 per cent of nickel and 0.12 per cent of carbon. It has a high tensile strength and very little elongation, while another nickel-steel equally good for other purposes contains 2 per cent nickel and 0.9 per cent carbon, and gives a high tensile strength with a great elongation.

Table III shows the different percentages of nickel in steel turned out by one manufacturer, and their strengths under different treatments.

These steels have percentages of carbon ranging from 0.10 to 1.00 per cent, and those with the highest percentages of nickel are used mostly for valves, owing to their heat-resisting powers combined with a great strength. Sometimes from 1 to 3 per cent of chromium is added to these valve metals to increase the elastic limit and mineral hardness.

* * *

A contemporary, in describing a new form of electric meter, makes use of what it calls an "exploded view" of the apparatus. In this view the parts are shown slightly separated, thus giving a better idea of the construction of the device. Presumably, a charge of powder is supposed to have been set off beneath the apparatus, and the picture represents a snapshot taken about 0.0000001 of a second after the explosion. The expression is a graphic one, but it sounds very queer.

CUT OUT ON THIS LINE

PUNCH O PUNCH O

These operation sheets, covering every class of shop work, are a feature of all Editions of MACHINERY, and appear every month. They may be cut along the top and margin lines for filing and binding. Suitable binders of sufficient capacity to hold four years' issues will be supplied by THE INDUSTRIAL PRESS, 49-55 Lafayette Street, New York, for 25 cents each, including postage.

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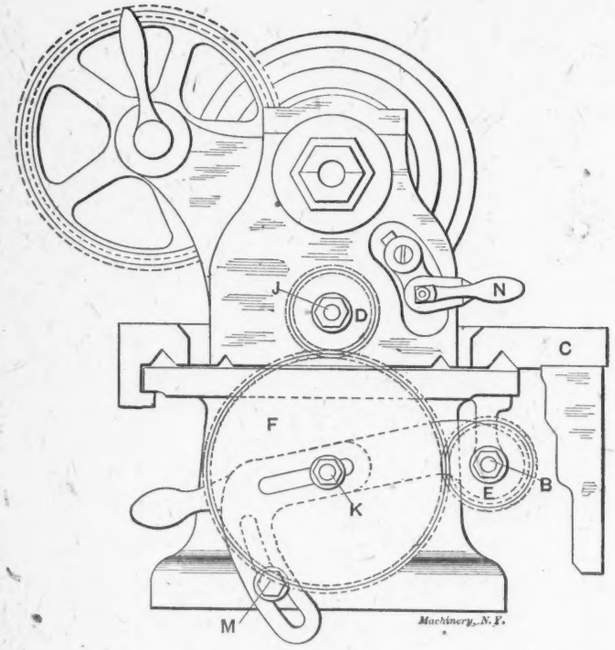
SHOP OPERATION SHEET NO. 13.

Oscar E. Perrigo. MACHINERY, September, 1907.



To Cut a Thread having the Same Pitch as the Lead-screw of the Lathe.

1. Rotate the spindle of the lathe one revolution by hand, and observe the movement of stud *J*, to see whether it makes one revolution or one-half, per turn of the spindle.

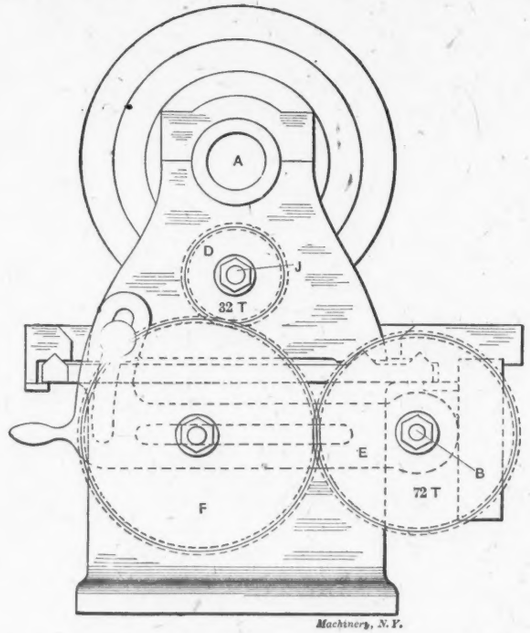
2. If stud *J* revolves one turn for one of the spindle, select from the set furnished with the machine two gears having equal numbers of teeth. Place one of them, *D*, on the stud *J*, and the other, *E*, on the lead-screw *B*. If the stud is geared to revolve at one-half the speed of the spindle, gear *D* on the stud must have twice the number of teeth possessed by gear *E* on the lead-screw.

3. Place on the intermediate stud, *K*, a gear *F* of any convenient number of teeth. Adjust it in position to mesh properly with gears *D* and *E*, and fasten it in position by the clamp screws or bolts at *K* and *M*.

4. With the nut on the carriage *C* thrown into mesh with the lead-screw, start the lathe up in the forward direction. If the carriage moves toward the headstock, the lathe will cut a right-hand thread of the same pitch as the lead-screw. If the carriage travels the other way, a left-hand thread will be cut. To change from right to left or *vice versa*, shift lever *N*, or make such other adjustment as is provided by the design of the lathe.

SHOP OPERATION SHEET NO. 14.

Oscar E. Perrigo. MACHINERY, September, 1907.



To Cut an 18-Pitch Thread in a Lathe having an 8-Pitch Lead-screw.

1. Observe whether the stud *J* revolves once for every turn of the spindle or for every two turns. If the latter, proceed as if the lead-screw were twice the pitch given, or 16.

2. Form a fraction having for the numerator the number of threads per inch of the lead-screw, and for the denominator the number of threads per inch to be cut. Reduce this to its lowest terms. Finding in Step 1 that stud *J* and spindle *A* are geared to run at the same rate, we have $8/18 = 4/9$.

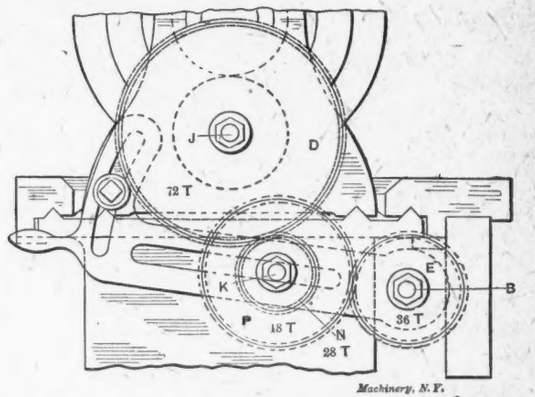
3. Find two gears from the set furnished with the lathe such that when one of them is used as the numerator of a fraction and the other as the denominator, this fraction, reduced, will equal that found in Step 2. Finding gears with 32 and 72 teeth, we have: $32/72 = 4/9$.

4. Place the first gear on stud *J*, as shown at *D* in the cut. Place the second gear on lead-screw *B*, as shown at *E*. Connect them by any suitable intermediate gear *F*.

5. To prove the correctness of the gears selected, multiply the number of teeth in gear *D* on the stud, by the number of turns per inch in the thread to be cut. Divide the product by the number of threads in the lead-screw, observing the rule given in Step 1 if the stud is geared 2 to 1 with the spindle. The result should be the number of teeth in the gear on the lead-screw, thus: $32 \times 18 \div 8 = 72$.

SHOP OPERATION SHEET NO. 15.

Oscar E. Perrigo. MACHINERY, September, 1907.



To Cut a 3½-Pitch Thread in a Lathe having a 6-Pitch Lead-screw, using Compound Gearing.

1. Observe whether the stud *J* revolves once for every turn of the spindle or for every two turns. If the latter, proceed as if the lead-screw were twice the pitch given, or 12.

2. Form a fraction having for the numerator the number of threads per inch of the lead-screw, and for the denominator the number of threads per inch to be cut. Reduce this to its lowest terms. Finding that the lathe in question has the stud geared 2 to 1 with the spindle, we form the fraction thus:

$$\frac{6 \times 2}{3\frac{1}{2}} = \frac{12}{3\frac{1}{2}} = \frac{24}{7}.$$

3. Next find four gears from the set furnished with the lathe, such that when the product of two of them are used for the numerator of a fraction and the product of the other two for the denominator, this fraction reduced, will equal that found in Step 2. Finding gears with 72, 48, 36 and 28 teeth, we have:

$$\frac{72 \times 48}{36 \times 28} = \frac{24}{7}.$$

4. Place either of the two gears in the numerator of the fraction in Step 3 (72, for instance) at *D* on stud *J*. Place either of the gears in the denominator (28, for instance) in mesh with it at *N* on stud *K*. Place the other gear, in the numerator, at *P* on stud *K*, meshing with the remaining gear of the denominator, 36, on the lead-screw *B* at *E*.

5. Prove the correctness of the calculation by multiplying together the numbers of teeth in the driven gears *N* and *E*, and the number of threads per inch of the lead-screw (taken at double its value in this case, as called for by Step 1). This product must equal the product of the numbers of teeth in drivers *D* and *P*, multiplied by the number of threads per inch it is desired to cut. Thus:

$$28 \times 36 \times 2 \times 6 = 12{,}096.$$
$$48 \times 72 \times 3\frac{1}{2} = 12{,}096.$$

HOBS FOR WORM GEARS.*

JOHN EDGAR.†

In the August, 1907, issue of MACHINERY, Mr. Flanders gives a very good treatment of both the worm and worm-gear, but he has very little to say regarding the hob. It is the desire of the writer to supplement his remarks by a few suggestions on the design and proportions of the hob.

If we were to make an extended collection of hobs from various sources, we would find a great variety in design and proportions. It is generally accepted as a fact that the hob need only be a duplicate of the worm, with the exception that it should be slightly larger in diameter in order to give a clearance at the root of the gear tooth. That such hobs are used and appear to give good results, is their only claim to existence. When we come to think that the teeth of the gear are dependent on the hob for their shape, and that the smooth-running qualities depend also on the same tool, it must be conceded that a little thought and care put into the production of the hob would not only repay for any extra trouble, but would be a source of longer life to the gear.

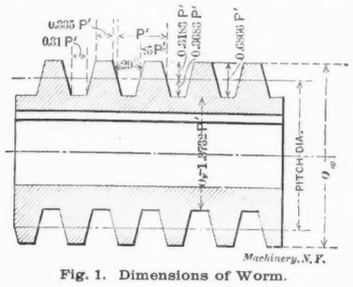


Fig. 1. Dimensions of Worm.

If a worm and gear of standard proportions are brought into mesh, we have at the bottom of both the thread of the worm and teeth of the gear a clearance equal to one-tenth of the thickness of the thread or tooth at the pitch line. The clearance at the root of the gear tooth is obtained by enlarging the hob over the diameter of the worm, by an amount equal to two clearances, while the clearance of the tooth in the thread bottom is taken care of by the proper sizing of the gear blank.

While it may be customary practice to make the hob an exact duplicate of the worm, except in the one item of outside diameter, a hob proportioned as suggested in Fig. 2 is recommended as one that will give much more satisfactory results, and be found to be well worth any additional trouble in construction required beyond that for the style ordinarily used. The peculiar feature of this hob is that it is an exact opposite of the worm with respect to the proportions of the thread shape; the depth below the pitch line in one case being equal to the height above the pitch line in the other. The object of this is to have a hob that will form the complete outline of the tooth and make it absolutely certain that the standard proportions of tooth and clearance are obtained. Thus, should the diameter of the blank be large, the hob will trim off the top of the gear teeth to the proper length, when the proper center distance is maintained.

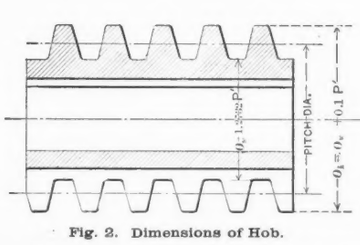


Fig. 2. Dimensions of Hob.

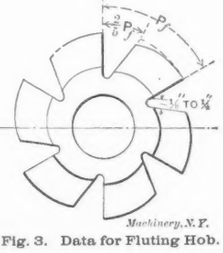


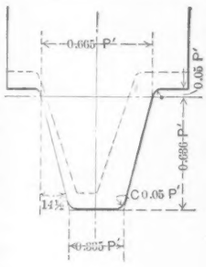
Fig. 3. Data for Fluting Hob.

There is another point that is generally overlooked, and that is the necessity for having the corners of the thread rounded over, and for providing a liberal fillet at the root of the thread. The radii of the rounded corner and the fillet may be as large as the clearance will allow, which would be one-twentieth of the circular pitch of the thread.

The effect that this fillet and rounded thread have on the shape of the tooth is something that greatly increases the quality of the gear and the strength of each individual tooth. The rounded corner on the thread points does away with any tendency to scratch the surface of the tooth in the cutting action, and leaves a much larger fillet at the root, greatly increasing the strength. The fillet at the bottom of the thread rounds off the top of the tooth in the worm-gear, removing any burrs, and leaving a nicely finished product. This fillet also removes the dangerous tendency of the hob to develop cracks in the hardening process—a common source of trouble even where care is taken. Fig. 1 shows the proportions of the worm in comparison with the hob in Fig. 2.

In forming the hob, much can be gained by making a special form tool of correct proportion that will leave no chance for error; the only dimension needing care then is the diameter. Such a tool is shown in Fig. 3. The figure is dimensioned by formulas, so that a tool for any pitch can be easily proportioned from it. This tool may be made by using a gear caliper without resorting to the protractor, or the protractor may be used in laying out the angle. This tool may be made without side clearance, providing that the sides incline in the same direction and at the same angle that the thread takes, but under ordinary circumstances, where only one hob is to be made, little is gained by having no side clearance. Clearance may be made from 5 to 10 degrees from the angle of the thread. [Grinding a tool like this of course changes its form, so it must not be used indefinitely in making large numbers of similar hobs.—EDITOR.]

The number of flutes that should be provided in the hob is a point on which very little is said, various authorities differing widely. Where the hob is to be used in an automatic hobbing machine in which the hob and blank are positively geared together, the number of flutes may be a comparatively small number as compared with a hob that is to be used in connection with ordinary processes of hobbing worm gears. In the process in which the previously gashed worm-gear blank is swung loosely on centers and revolved by the hob as the latter rotates, the hob should have a larger number of flutes.



A rule that checks up well with present practice is as follows:

To find the number of flutes in a hob, multiply the diameter of the hob by three, and divide by twice the circular pitch.

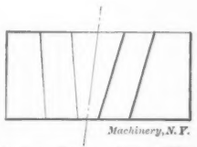


Fig. 4. Dimensions of Tool for Threading Hob.

The above rule gives suitable results on hobs for general purposes. When the result gives an odd number of teeth, take the next smaller even number, to facilitate calipering.

Some authorities on worm-gearing state that the number of flutes in a hob should in no case be an exact multiple of the number of threads. Their reason for this rule is that the hob so gashed will produce a much smoother tooth and one nearer correct in shape, because no tooth in the hob passes the same tooth in the gear twice in succession, so that any little imperfections in shape of the individual hob teeth are counteracted by one another. Another authority is strong in his advice not to have the circumferential distance from flute to flute equal to or equally divisible by the circular pitch of the hob, for the same reason as stated regarding the former rule. From these statements, it is seen that to obtain a rule that would be at once simple and yet take all conditions into consideration, would be a difficult proposition. [So far as we can see, only the first of these two rules is a logical one. Owing to the fact that hobs have teeth only, instead of full surfaces matching the worm, the curved outlines of the wheel teeth are merely approximated by a series of tangents. If the number of flutes in the hob is a multiple of the number of threads, the hob teeth will "track" after each other, giving wheel teeth only roughly approximated by a comparatively small number of long tangents.—EDITOR.]

The cutter used in gashing the hob should be about ⅛ inch thick at the periphery for hobs of ordinary pitch, while for those of coarser pitch a cutter ¼ inch thick would be much

* For further information regarding worm gearing, see MACHINERY, August, 1907: Calculating the Dimensions of Worm Gearing, and other articles referred to in that issue.

† Address: 7 Webster St., Hyde Park, Mass.

better. The width of the gash at the periphery of the hob should be about two-fifths the pitch of the flutes. The cutter should be sunk into the blank so that it may be from 3/16 to ¼ inch below the root of the thread. Fig. 4 shows an end view of a hob gashed according to these rules.

Where a hob is to be used to any great extent, and is subject to much wear, it would be advisable to increase the diameter above the dimensions given from 0.010 to 0.030 inch according to its diameter and pitch, to allow for decrease in diameter due to the relief, and caused by grinding back the cutting face in sharpening.

Hobs are generally fluted parallel with the axis, but it is obvious that they should be gashed on a spiral at right angles with the thread helix in order that the cutting face may be presented with theoretical correctness; but the trouble encountered in relieving the teeth on the ordinary backing off attachment is the cause of the common mode of fluting. When the pitch or lead is coarse in comparison with the pitch diameter of the hob, so that the angle is correspondingly steep, it may be best to flute on the normal helix, and if the hob cannot be machine relieved, it may be backed off by hand.

The amount of relief depends much on the use for which the hob is intended. A hand hob for hobbing a gear in position may be made with little or no relief, while hobs used on hobbing machines may have much more relief than those used on the milling machine.

In closing, I would suggest that Mr. Flanders' model drawing give the full data relating to the thread, such as the whole depth, the width of the thread at top and the space at the bottom. The pitch diameter would also be handy to have, as would also the center distance.

* * *

WITH THE REPAIR GANG.

A. P. PRESS.

Down at one end of the O. C. R.R. round-house there was a long L where they did the repair work, and where we used to hang out when there wasn't much to do. There was a boilermaker, a few machinists, and two or three blacksmiths. Jim Haven was the boss of the smiths, and did the hiring and firing for the lot. One day in came a big, stout fellow and he asked Jim if he wanted a good blacksmith.

"Can you weld two pieces of iron together?" asked Jim.

Now this was equivalent to asking a bookkeeper if he could write, and the man was mad. He didn't say much but remarked: "You just give me a chance and I'll show you whether I can or not." "All right," said Jim; "it's almost 12 o'clock and I am going to dinner, but the power runs all the noon time, and there's fire and there's plenty of stock here. See what you can do while I am gone."

"Can you weld two pieces of iron together?"

He waited until Jim got washed up and out of the shop. Then he picked out two pairs of the biggest and best tongs in all the bunch. He gripped the jaws right into each other, put a ring on each end of the tongs, put them in the fire, brought them up to a good heat, put them under the hammer and made as pretty a weld as ever you saw! Taking a stamp we use to mark O. C. R.R. on all the tools, he struck it on four sides of the job, laid it on Jim's anvil, washed up and got out.

Well—when Jim got back, the air was blue, for Jim wasn't any Sunday-school teacher and he could say things that I don't want to write, and you wouldn't print them if I did, but after he cooled off, he said: "Well, that's a good job; if he comes along again, I'll hire him."

One day old 76 ran her nose into a snow-drift up on Long Plain Hill, and buckled up her side-rods. You see the front drivers stalled in the snow, but the rear ones didn't; they sent us up there, and we towed her down to the house for repairs. We took off the rods and carried them in to Jim to straighten up.

There was a smell of burned leather.

He took a heat on them, worked out the kinks, lined them up on the centers. When they were all done he told the helper to set them away over in the corner, and then go and tell the round-house boss that they were all right. They were "black hot" and the helper took a pair of tongs and lugged them over to the corner and set them up.

Now there was a kind of "kid-glove" apprentice out in the round-house on whom we thought it was all right to put up a job any time, and Jim thought the round-house boss would send him in after the rods—and he did. The "kid-glove" fellow used to wear a pair of gloves most of the time, and I suppose that is why we were down on him. In he came, gloves and all, and asked Jim where the rods were.

"Over there in the corner," Jim replied.

He went over and grabbed a rod. There was a smell of burned leather, a string of swear words, and Eben came back to the smith's part.

"Why in the dickens didn't you tell me they were hot?" "Why any boy could tell they were hot; even my boy Tommy, coming in there with my dinner, could tell it." "It is a lie," said Eben. "It is, is it? Tommy, come over here and see if you can carry one end of that side-rod with Eben."

Now Tommy was wise, and he knew his father a good deal better than Eben did. He went over to the corner, wet his finger in his mouth and touched both ends of the rod. Then, taking hold of the cold end, he waited for Eben to take hold of the other, which he did with the tongs.

Bill put some oil on Eben's hands and cooled off the rods for him, but Eben went off with a look on his face that said: "I'll get even with Jim some time," and he did, as I will tell you later.

A DRAFTING APPRENTICESHIP COURSE.

Something more than a year ago the need for young draftsmen trained in locomotive detail work became so imperative, and the difficulty of getting them so great, that the engineering department chiefs of the Schenectady plant of the American Locomotive Company organized an apprenticeship course in mechanical drawing and locomotive design with the object of making their own men instead of depending upon the uncertain and generally unsatisfactory general supply. The move was made for no philanthropic motives whatever, but simply for the very good business reasons that have caused other large concerns to organize apprenticeship courses in shop work. This course also includes shop instruction, but it is simply given to round out the graduate draftsman's knowledge of locomotive construction and shop methods, and give his training the practical turn required of a first-class man. The result after one year's work is very satisfactory. About twenty young men are taking the course, and some are now working over the board in the general drafting department. These young men are doing good work in the main,

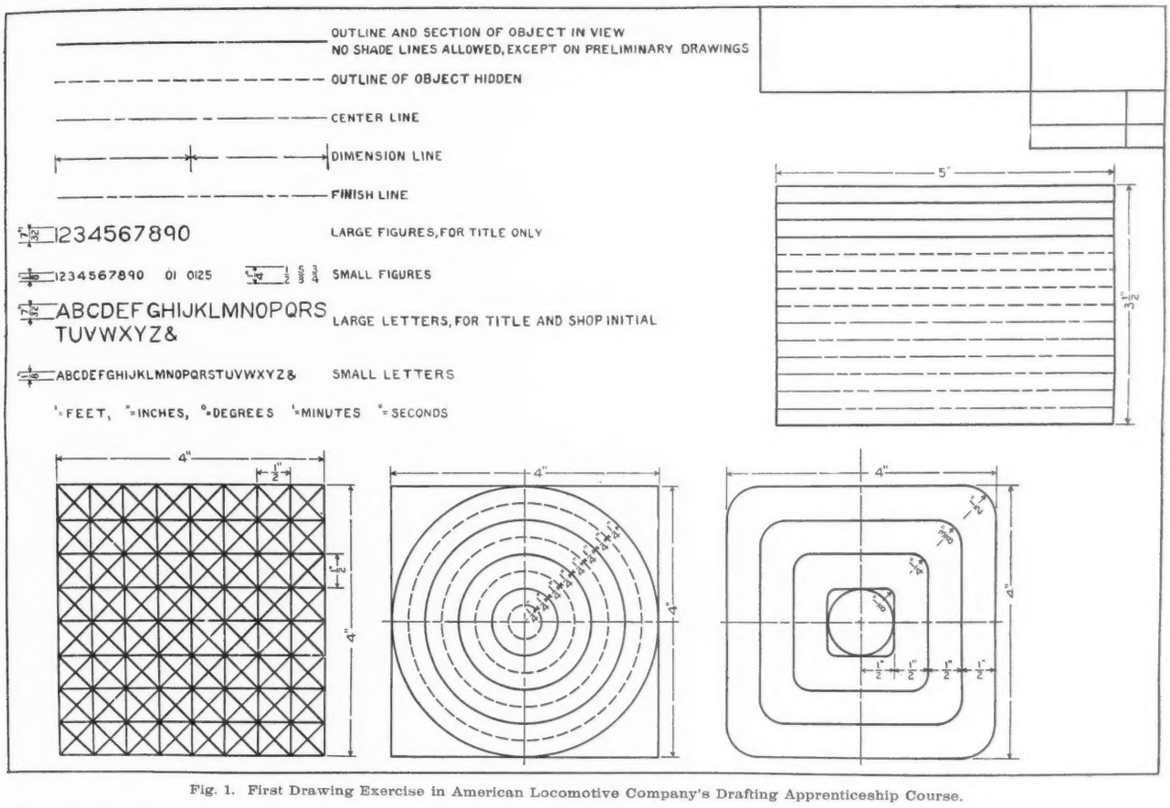


Fig. 1. First Drawing Exercise in American Locomotive Company's Drafting Apprenticeship Course.

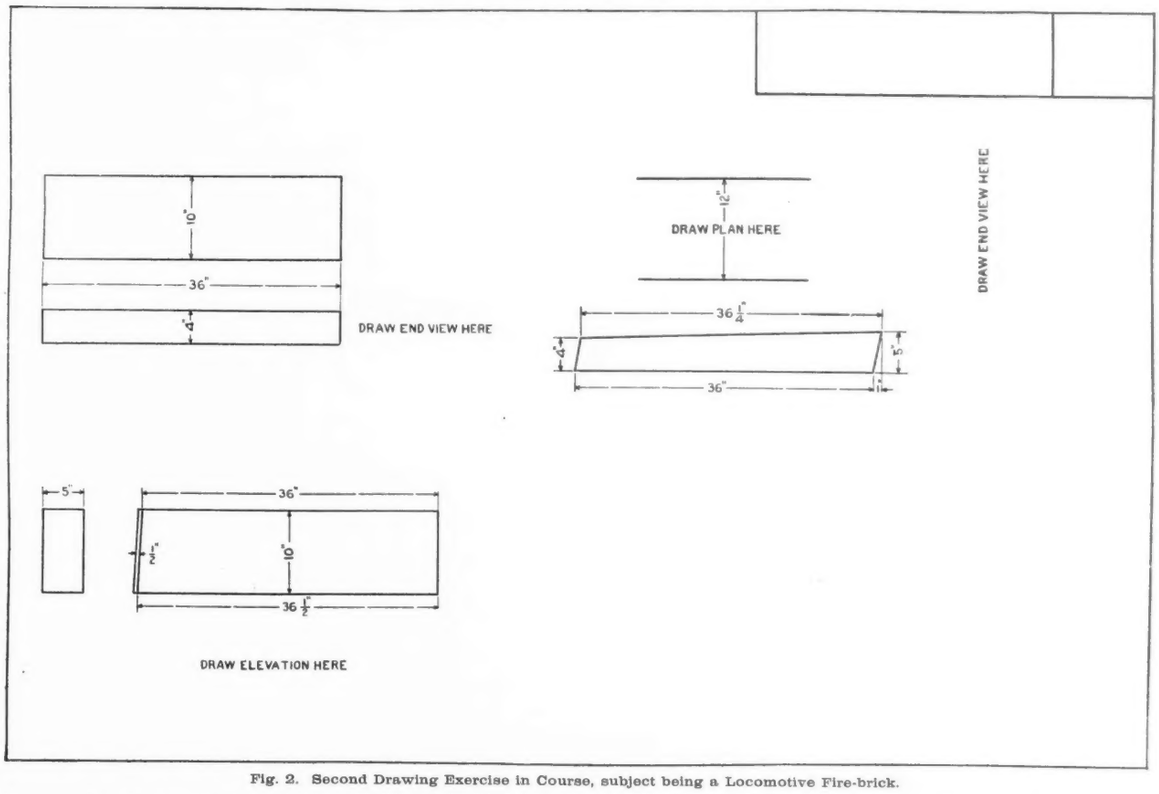


Fig. 2. Second Drawing Exercise in Course, subject being a Locomotive Fire-brick.

and are building themselves up into just the kind of men which the course was designed to provide.

The apprenticeship course in drafting is offered to a limited number of young men between the ages of sixteen and nineteen who can read, write, and answer certain simple questions in oral arithmetic. They are taken in on one month's trial, and then, if satisfactory, are admitted to the regular four years' apprenticeship course upon signing an indenture. The first, third and fourth years are to be spent in the drafting office, and the second year in the shop, receiving instruction in the use of tools and erection of locomotives. The first three to six months are spent in the blueprint room, making and fixing blue-prints, etc.

The apprentices, while at work in the drafting office, are given regular instruction, during working hours, in drafting, algebra, geometry, trigonometry, descriptive geometry, applied mechanics, strength of materials, and machine design, and they are taught the general application of these subjects to drafting room and engineering problems. The apprentices are divided into small classes for receiving instruction, in order to get the benefit of close contact with the instructor.

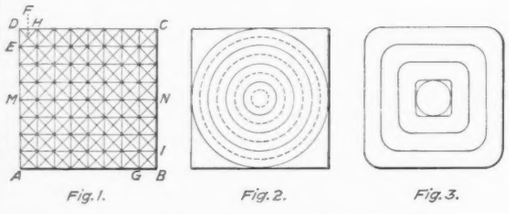


Fig. 1. Fig. 2. Fig. 3.

For dimensions of these figures see drawing exercise No. 1.

Fig. 1

1. What is the area in square inches of ABCD?
2. What is the area in square inches of the triangle ABD?
3. What is the area in square inches of the triangle DEF?
4. What is the length of the line DB?
5. What is the length of the line EG?
6. What is the length of the line EH?
7. What is the area of the rectangle EHIG?
8. What is the area of the rectangle MNBA?
9. What is the area of the triangle EHD?
10. What is the area of the figure HDEGBI?
11. What is the area of the figure DBGE?

Fig. 2

12. What is the area of the largest circle? (in square inches)
13. What is the area of the ring between the circle whose diameter is 3 inches and the circle whose diameter is 2 inches?
14. What is the area of one of the four corners spaces between the square and the inscribed circle?
15. What would be the diameter, in inches, of a circle circumscribed about the square?

Fig. 3. Examination Paper Based on First Drawing Exercise.

Each apprentice devotes four hours a week to recitation during the three years spent in the drafting office, but during the year spent in the shop the recitation hours are omitted, it being considered better policy not to interfere with regular shop routine. After the completion of the course the apprentices will be given a bonus of $150 over their regular wages, and they will be encouraged to remain in the employ of the company.

The instruction is of a strictly practical nature, the subjects being treated so as to have an immediate application to the regular work of the drafting office. There is no long preliminary course during which the students become discouraged because they do not see the use of the things taught.

The first drawing exercise is illustrated in Fig. 1. When this is satisfactorily accomplished the apprentice is given work of a simple nature to do in the apprentice drafting class. While this exercise is of a very simple nature, it contains the practical basis for future work including lettering, dimension lines, center lines, etc. Fig. 3 is a reproduction of a sheet using the same figures for an elementary examination paper on areas, etc.

The second drawing exercise illustrated in Fig. 2 has for its subject a locomotive arch firebrick which is kept in the recitation room and which forms the subject for numerous questions relative to its area, weight, density, volume, etc.

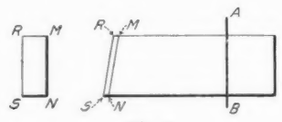
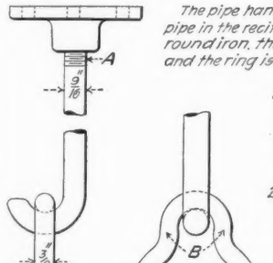


Fig. 12.

For dimensions of this brick see drawing exercise No. 2.

1. What is the area of the upper surface of the fire brick shown by fig. 12? (as shown by the plan view)
2. What is the area of the bottom surface?
3. What is the area of the cross section at A–B?
4. What is the length of the line from M to N?
5. What is the length of the line from R to S?
6. What is the length of the line from R to M?
7. What is the length of the line from S to N?
8. What is the area of the end surface of the brick which is beveled?
9. What is the area of each side of the brick? (as shown by elevation views)
10. Supposing the brick to have been originally 37½ inches by 10 inches with all corners square, how much bottom surface (expressed in square inches) was cut away by bevelling the brick?
11. How much was cut away from the upper surface?
12. How much was the area of the end which was bevelled increased by the process?
13. What are the cubical contents of the brick of fig. 12?
14. Supposing the brick to have been originally 37½ inches by 10 inches by 5 inches with all corners square (a rectangular parallelopiped), what was its original volume and how many cubic inches were cut away in bevelling it?
15. How much does the brick of fig. 12 weigh, if fire brick weighs 120 pounds per cubic foot?

Fig. 4. Examination Paper Based on Second Drawing Exercise.



The pipe hangers which support the water pipe in the recitation room are made of 9/16" round iron, threaded (see sketch and hanger) and the ring is made of 3/8" round iron.

1. If the thread is U.S. standard, what load will each hanger support before there will be a tensile stress of 6,000 lbs. per square inch at A?
2. What load could be supported by the hanger before there would be a tensile stress of 6,000 lbs. at B? (½ of the load is supported by each side of the ring).
3. Suppose the load upon the hanger to be 1,200 lbs., what would be the fibre stress due to tension at A and at B?
4. If the ultimate strength of the material is 54,000 lbs., what is the factor of safety with a load of 1,200 on one hanger?
5. If the load upon one hanger were 1,200 lbs., what would be fibre stress due to tension at A?
6. If the ultimate strength of the material is 54,000 lbs., what is the factor of safety with a load of 12,000 lbs. on a hanger?
7. With an ultimate strength of 54,000 lbs. per sq. in., and a factor of safety of 6, what load could be put upon each hanger? (Assume the weakest point to be at A)
8. (a) Suppose each foot of pipe, including fittings and the contained water, weighs 7½ lbs., how long a portion of the pipe would each hanger support before there would be a tensile stress of 6,000 lbs. per square inch at A?
   (b) Approximately, what length of pipe does each hanger support at the present time?
   (c) Approximately, what load is upon each hanger at the present time?
   (d) Using the load as obtained under (c), what is the stress due to tension at A?
   (e) With the load as found under (c) and an ultimate strength of 54,000 lbs., what is the factor of safety?

Fig. 5. Examination Paper on Strength of Materials.

The nature of these questions is shown in the reproduction of an examination paper, Fig. 4. The sheet shown in Fig. 5 illustrates practical examples in strength of materials. The few examples chosen will serve to give some idea of the nature of the instruction.

LETTERS UPON PRACTICAL SUBJECTS.

PUNCH AND DIE FOR ARMATURE DISKS.

The accompanying cut shows a compound die for armature disks for the cores for electric motors. The punch and die are shown in plan views and also in cross sections in Figs. 1 and 2. The die holder *A*, Fig. 1, is of cast iron, and is first planed on the bottom. It is then strapped to the face-plate of a lathe, and faced and bored to receive the plate *B*. This plate is also first faced on the bottom. It is then turned over and bored to the outside diameter of the disk to be punched; the depth of the bored hole is about ¼ inch. The die sections *C* are all milled in a fixture; they are then drilled and tapped for ¼ inch flat-headed screws. After this, the sections are hardened and tempered. The plate *B* and the sections *C* are then assembled, and after being assembled the sections are ground. The inside ring *D* is now machined. The keyway and marking notch are tapered one-half degree for clearance; the large hole for the shaft in the armature tapers also one-half degree.

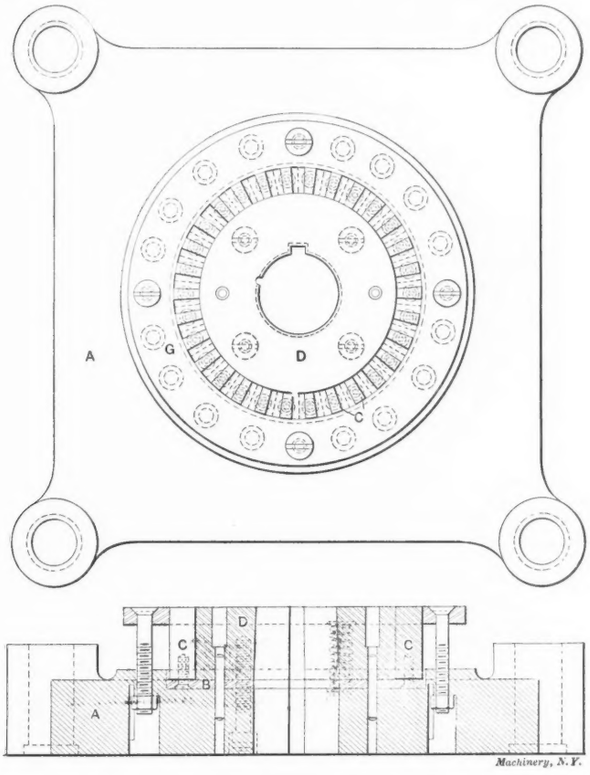


Fig. 1. Die for Making Armature Disks.

The ring is drilled and tapped for four ½-inch screws, and drilled and reamed for two dowel pins. After this the ring is hardened, tempered and ground to a very close fit in the circle formed by the sections *C*. The center hole is also ground to the required dimension. The stripper is now made, the working of which is plainly seen from the cut, and the whole is assembled, and the die is ready.

We are now ready to proceed with the punch. In this, *E*, Fig. 2, represents a tool steel ring, which, after it is machined, drilled and tapped, is hardened and ground. Punch sections *F* are located in the plate *G* which is milled with the proper number of slots. The punch sections should be left a little softer than the die, because the punch and die will wear much longer and give much better results if this is the case. The sections *F* are held in place by a ring *J* which is shrunk on the outside at the bottom. At *H* and *I* are shown the punches for the keyway and the marking notch. These are fitted into the center punch, being dove-tailed into this. They taper from the bottom up when the punch is in working position, and are driven in so that when punch *K* is assembled they cannot work out. The holes for the sub-press pins are drilled and reamed with the punch and die together, and the holes in the die counterbored to a depth of about ⅜ inch. The pins should be a driving fit in the die and a working fit in the punch.

M. J. W.

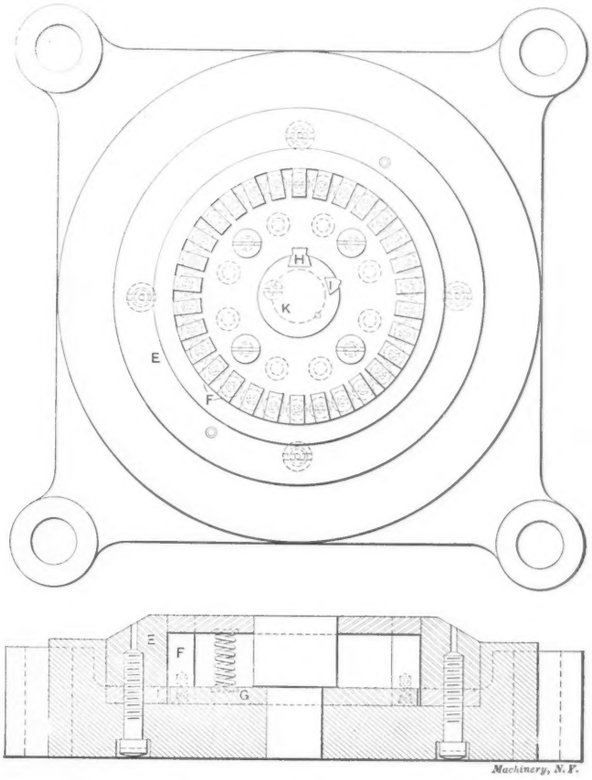


Fig. 2. Punch for Armature Disks.

ECONOMY WITHOUT DISCRETION.

The following incident shows the mistake of letting a non-practical man have charge of the red tape. In a certain small-sized manufacturing company, which had always paid fair dividends, the management thought that things could be run more economically, and as one of the directors knew a man who was considered an expert in weeding out all unnecessary expenses, it was decided to give him a trial. A few days after this a little sharp-nosed man came hustling around the shop asking every imaginable question in a snappy manner—he was the expert. His new methods were first noticed by Ed., who came down on the 6:55 train, and thus could not get to work before 7:05 A. M. He found he was being docked one-half hour every morning for being late. Ed. had been with the firm for over eight years, and was a good, conscientious workman, who kept first-class time, other than the five minutes late every morning, and then he always stayed until 6:15 P. M., because his train did not leave until 6:30. It made no difference, the expert said, their time was 7 A. M., and train or no train Ed. must be there or be docked half an hour. Things went fairly well until Saturday, when the expert came in about ten minutes before quitting time and caught the boys just starting to clean their machines; then there was a roar. "Ten minutes is too long to take to clean up; in the future only five minutes will be allowed," and he walked out. The following week the supply of files, hack-saw blades, waste and oil was cut to about half the usual amount, and more than that would not be given out, no matter how urgent the need; next, notices were put up saying that from the first of the month all work would be given out on time limits, and every man must keep within these limits. The result of this was that all jobs were faked up just enough to get through the shipping department without defects being noticed. The expert did not think of appointing any inspectors.

A few weeks after this a lot of tool steel came in, and then

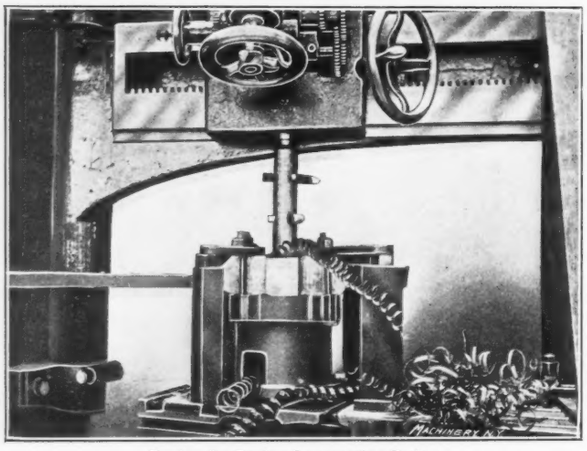
the trouble began in the hardening department. The new steel was of the "cheap" kind, and after the die makers had spent days of work forming it into dies, it would crack or spring badly when it came to the hardening room. The final result of all this was that the working expenses were higher than ever, and the expert said that the general foreman was trying to "do him," so he had him fired for inefficient results. This caused a general strike, and the directors held a special meeting and had the whole matter investigated, and found out where the real trouble was, so they fired the expert, and reinstated the foreman, and since then there has been no more false economy in the form of cheap steel, insufficient supply of files or any other little meanness—and the firm has not lost by the change.

PENNSYLVANIA.

BORING LOCOMOTIVE RODS.

The cut herewith shows an old Pond radial drill press fitted up temporarily for boring new locomotive side rods for bushings. This machine has been in constant use for twenty years, several years of this on a double shift. To the extreme right in the cut a triangular brace is shown, bolted at the base to the table of the machine, and clamped to the radial arm at the top to give greater rigidity to the machine.

A special cast iron jig was made as shown for boring the rods, having provision made for bolts to hold the rods down, and high enough to allow the three one-inch square high speed steel tools in the bar to pass through the rod without coming



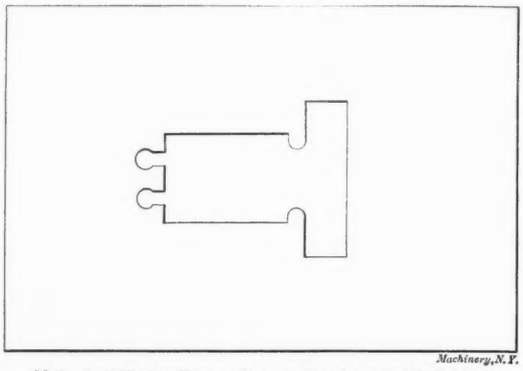
Device for Boring Locomotive Rods.

in contact with the table of the machine. The boring bar is three inches in diameter and extends through a hole in the table. The tools are sufficiently far apart so that just as the first one leaves the cut, the next one is starting a fresh cut. These tools are set out so that each one is ¾ inch further out than the preceding one, and consequently the hole will be enlarged from 3 inches to 7½ inches by passing the bar through once. Special attention must be given to grinding the tools with enough top rake, and very little front clearance. If this is done, and the belts kept in good condition, it will be surprising what a large amount of chips can be removed in one hour. Next to having one of the modern two-spindle two-thousand dollar rod boring drills installed, I would recommend fitting up one of the old radials as shown.

Port Huron, Mich. M. H. WESTBROOK.

CONSTRUCTION OF DIES TO PREVENT BREAKAGE IN HARDENING.

Having read an article which appeared in the March, 1907, issue of MACHINERY relative to hardening dies with small projections or tongues, in which the possibility of breakage is large, I herewith give the method of practice in some shops where I have been employed. We will take, for instance, the die that was shown in the article to which I refer. This die I propose to make in the following manner. The die is first filed or machined in the regular way, with the exception that the two tongues are left out. In line with the center of the tongues and at a cetrain distance from the cutting edge, holes are drilled larger than the width of the tongues. These are taper reamed from the top with a standard taper reamer. A slot is then cut from the hole into the die the same size as the tongue, when the die would look as shown in cut. We now make two pieces to fit in the holes, and extend out the required distance, making sure that they will be a drive fit after hardening. It is best if the pieces are 1/32 inch longer than the thickness of the die, so that they can be ground flush after being driven into place. While this may increase the cost of producing the die, yet, if from any accident, one or



Method of Making Dies to Prevent Breakage in Hardening.

both tongues should be broken, they are easily replaced without the necessity of annealing the die. While I do not wish this article to be taken in the nature of a criticism, it is to the interest of all readers if some discussion of such subjects is entered into.

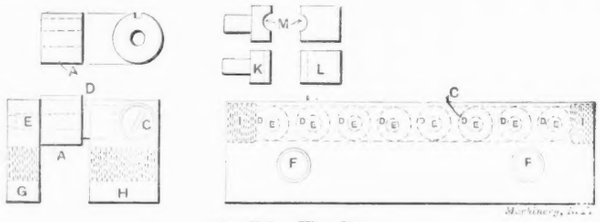
We do not use the same method of holding punches in the punch pad as the writer referred to, as the necessity of turning the punch from large stock to leave the head large enough is an expensive operation. We make the punches 0.001 inch or 0.0015 inch larger than the holes in the punch holder, and just before they are driven home, we rivet the upper ends of them, which are drawn soft enough for the purpose. If the punches are set properly, it will be impossible to pull them from the holder, for the friction on the body of the punch is greater than it would be in any metal on which the punch would stand up.

K. L. Ross.

ST. LOUIS, MO.

PUMP VISE JAWS.

The accompanying cut shows a handy device for use on a milling machine for slotting pieces such as shown at *A*, and also for slotting screw heads. The vise jaws *G* and *H* are made out of tool steel, and are left soft; they are placed in a milling machine vise, and the piece *A* to be slotted is placed between the two jaws, as shown. The chamber *C* is a cylindrical hole into which are drilled holes from the side for the cylindrical plungers *D*. The chamber *C* is filled with tallow,



Equalizing Vise Jaws.

and, as the pieces *A* are clamped in between the plungers *D* and the vise jaw *G*, the tallow provides an equalizing effect until all the parts are held equally firm. This means permits pieces of a slightly uneven length to be held securely. The plungers *D* must, of course, be a very good sliding fit in the holes running down to the chamber *C*. The pin *E* simply serves the purpose of locating the piece *A* by entering the hole in its center. The holes *F* are tapped to receive screws holding the jaws to the milling machine vise. Pieces *E* and *D* should be made of tool steel and hardened. When screw heads are slotted the parts *K* and *L* are used instead of *D* and *E*. The screws are then held in the semi-circular grooves

M, the operation of the device being the same as when slotting pieces *A*. The screws *I* in the ends of the circular chamber *C* simply serve the purpose of preventing the tallow from escaping at the ends. S. OLIVER.

Great Barrington, Mass.

TO FIND THE NUMBER OF CUTTER FOR SPIRAL GEARS.

The calculations of spiral gearing has been fairly well discussed in these columns, and many formulas and time-saving methods have been presented, but these all had reference to the determination of the dimensions of the gears themselves, while the method of determining the proper cutter to be used has not been simplified.

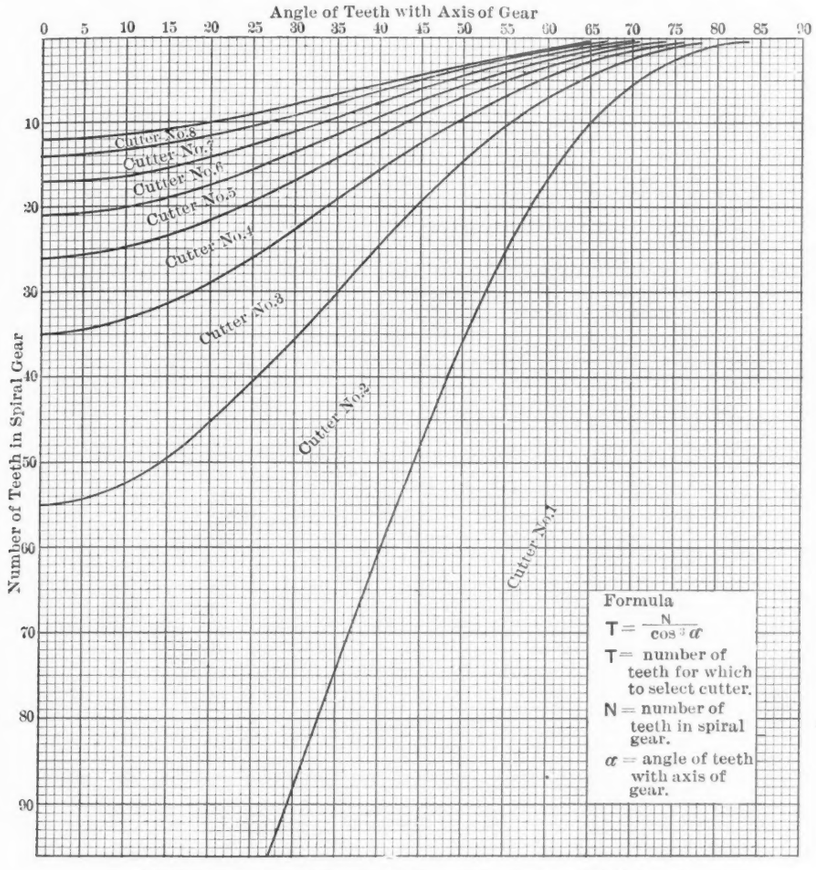

Angle of Teeth with Axis of Gear
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
Number of Teeth in Spiral Gear
10 20 30 40 50 60 70 80 90
Cutter No.8
Cutter No.7
Cutter No.6
Cutter No.5
Cutter No.4
Cutter No.3
Cutter No.2
Cutter No.1
Formula
$T = \frac{N}{\cos^3 \alpha}$
T = number of teeth for which to select cutter.
N = number of teeth in spiral gear.
α = angle of teeth with axis of gear.

Diagram for Finding Number of Cutter to use for Cutting Spiral Gears.

The cutter used in milling spiral gears is, of course, understood to be a standard spur gear cutter, the only difference being, that the *number* of the cutter used to cut a spur gear of, say, thirty teeth, will not necessarily be the same number of cutter that is used to cut a spiral gear of thirty teeth, it of course being generally known that the angle of the teeth with the axis of a spiral gear is another factor affecting the tooth form, and, therefore, the number of the cutter. However, spiral gears are correctly cut with spur gear cutters, the problem being, to find the proper number of cutter to use.

The selection of the cutter has been determined by the formula:

$$T = \frac{N}{\cos^3 a},$$

in which

N = actual number of teeth in the gear,

a = angle of teeth with the axis,

T = number of teeth for which to select the cutter.

This number, T, is sometimes called the "apparent" number of teeth in a spiral gear.

This relatively unimportant operation of calculation often involves more labor than the determination of the pitch diameter, etc., inasmuch as we have to cube a cosine. The result, moreover, is to merely give the "apparent" number of teeth in the gear, and from this result, we look up the table of cutters, to find the actual number of cutter to use.

Each cutter number covers a "group" of teeth, as for example, No. 2 cutter cuts from 55 to 134 teeth in a spur gear; therefore, by plotting a series of curves, we can represent the group covered by each cutter, by the field between two of the curves.

The accompanying diagram enables one to determine the number of cutter to mill a spiral gear, without any calculation, by simply locating the point corresponding to the actual number of teeth in the gear, and the angle of the teeth with the axis. This point then falls within the area of one number of cutter. This diagram, unlike most diagrams, gives exact, and not approximate, results, because of the fact that we are dealing with groups instead of definite quantities or amounts.

The writer has found this a great time-saver, and hopes that it may be of assistance to others.

ELMER G. EBERHARDT.

Newark, N. J.

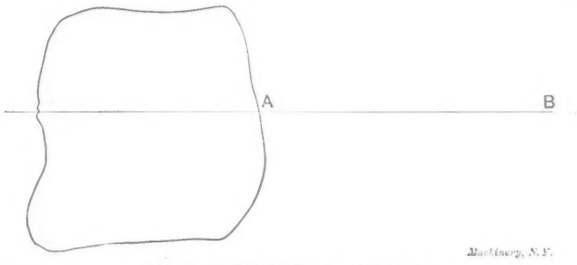
POCKET KNIFE PLANIMETER.

The following application of the knife as a planimeter is very useful and accurate to one or two per cent. I have never seen the method published, and think that it might be of interest. As shown in the cut below, a straight line is first drawn through the figure, the area of which is to be found. A common penknife or jackknife, having at least two blades, is then opened so that the large blade is entirely open, and the small one perpendicular to it. The knife is then placed on the paper with the plane of the blades perpendicular to it, the small blade at the intersection of the figure and the straight line, and the large blade on the straight line. With the left hand holding the large blade lightly against the paper, the small blade point is made to follow the outline of the figure with the right hand. When the starting point is reached, the distance of the large blade from the line multiplied by the distance between the points of the knife will be the area of the figure. H. D.

[The accuracy of the "hatchet" planimeter, of which the pocket knife used in the form described is an example, depends very largely upon the alignment of the knife edge and the tracing point. The prolongation of the axis of the blade section in contact with the paper should pass exactly through the point of the little blade used for tracing. The ordinary pocket knife seldom fulfills this condition, hence the method is more interesting than useful.—EDITOR.]

SCREW SLOTTING FIXTURE.

The cut on next page shows a fixture designed to slot screws and other similar articles. The fixture is to be used in con-

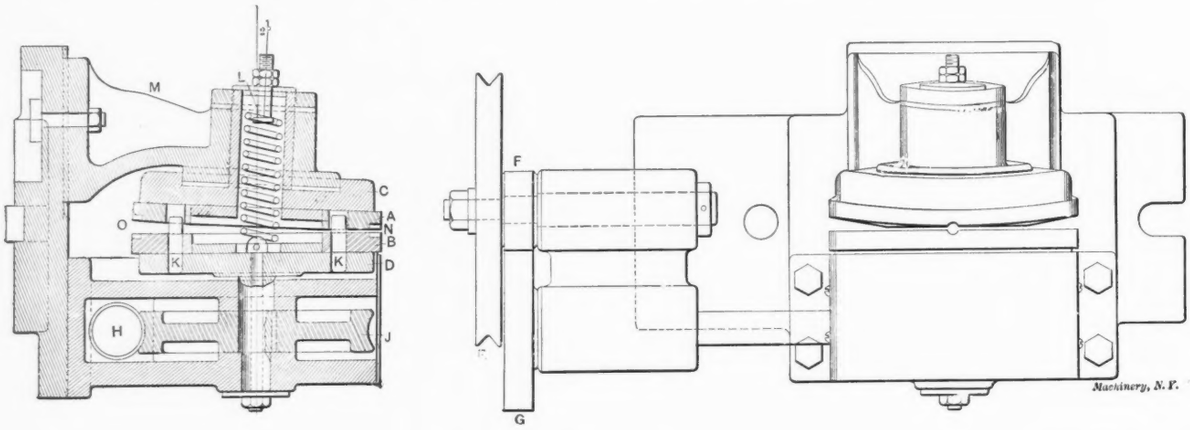


Using a Pocket Knife as a Planimeter.

nection with a milling machine. At *A* and *B* are shown two rings of machine steel, case-hardened, with holes drilled on

their peripheries suitable to grasp the work to be slotted. The number of holes will vary according to the speed at which the fixture is run and the work being slotted. The rings are held and located on the holders *C* and *D* by screws and dowel pins not shown in the cut. Holder *D* is driven by means of a belt from the countershaft to grooved pulley *E* and through spur gears *F* and *G* and worm and worm-wheel *H* and *J*. Holder *D* is made in one piece with the worm-wheel shaft. Holder *C* is in turn driven by holder *D* by means of pins *K* held in holder *D*. Spring *L* takes care of any variation which may exist in the size of the pieces being slotted.

To locate and drill the holes, which retain the work, in rings *A* and *B*, they are screwed and doweled on the holders, and the fixture placed on a drill press in such a manner that an equal section of the hole will be drilled in each ring. The rings are then case-hardened. For different pieces of work it is merely necessary to make different rings to suit the conditions of the piece. The bracket *M* is adjustable forward and backward to allow different thicknesses of rings to be used. The hole in bracket *M* is bored at an angle of 2 degrees, and the plate *A* is also faced off at the same angle, so that it



Screw Slotting Fixture.

will be parallel to ring *B* at *N*. By boring the hole at an angle, it will be readily seen that at the point *O* the space between the two rings is the greatest, and at point *N* the least. In operating the fixture, it is placed on the milling machine so that the slotting saw will pass directly through the center of the piece, and directly over the center of the rings. The fixture is then started, and the operator only inserts the work in the holes. As will be seen, the piece is gripped firmly while passing under the saw, and automatically dropped when reaching the bottom.

Montreal, Canada. FRED R. CARSTENSEN.

WHAT A FOREMAN SHOULD BE.

A man may hold a position as foreman and still possess few of the qualities that go to make up an ideal one, and on the other hand a man may possess many of the qualities of the ideal foreman and still remain in the ranks all his life. Luck, push or pull may have put the first man into the place, but these alone seldom keep a man there. On the other hand, it may be the lack of push alone that has deprived the second man of his birthright. My experience has been confined mainly to machine shops, but the principal qualities that make a successful machine shop foreman are the same that are required in other branches of business. Leadership, experience, tact, self-control, foresight and system, are among the qualities that *should* be present, but often several of these are absent, and the man still counted a success from the employer's point of view. A man may be a brute to the men under him and still make money for his employers, but I am not going to discuss this.

In the first place a foreman, as the word implies, should be a leader, that is, a man who naturally leads others, and in this connection a good physique is a great aid, though not always a necessity; then comes experience, for a man can hardly be successful in solving the problems that constantly arise, and which require instant decision, without a certain amount of experience to back his judgment, and nothing so quickly shakes a man's confidence in his foreman, as the latter's lack of sound judgment. However, good judgment and common sense will make up for the lack of a vast amount of experience. Common sense prevents a man giving orders which are absurd on the face of them. An instance occurred in a shop not long ago that illustrates this. Some iron collars were to be shrunk onto pins, turned for the purpose. The foreman, a new man, ordered the pins heated and driven into the collars. As a result of this foreman's order a lot of pins were spoiled and he was made the laughing stock of the whole shop. It is needless to add that this kind of a foreman "lasts quick," as the saying is.

As for tact, it enables a man to get along where a lack of it has caused strikes and discontent. A tactful foreman does not give orders to the skilled, high-class mechanic in the same tone that he uses in ordering about a lot of meddlesome boys, or in telling the "roustabout" to do a better job of sweeping. This kind of a foreman studies his men, studies their little weaknesses and pet ideas. One man he asks about the ball score and another if he has read that piece in the last magazine about hardening steel. A certain man, or two, gets all the particular jobs, while another who likes brass work is given the preference in goods of that class whenever possible. Thus it goes all through the shop, placing work where it will be done the quickest and best, and keeping the human machinery oiled as well as the other kind. In order to get the best results from his men, a foreman must not only command their respect in regard to his judgment, but also as to his personal habits. A dirty, slovenly, drunken boss, no matter how good a mechanic, cannot hold the respect of his men, and the shop will reflect his personal habits.

Again, in order to keep the shop going so that no time is wasted, he must plan ahead. He must keep watch of his men and calculate accurately when a certain man will finish a given job and have another ready for him. He must watch his supply of material and order more, in good season, making ample allowance for delays in the order department both of his own shop and the one from which it is purchased, as well as for the time required in transit. All these things he must keep in mind, and look ahead as an engineer glances along the track to see if all is clear. Added to all this he must use system. He must have his machines grouped so that the work can travel from one to the other with the least possible difficulty in handling. He must have things so arranged that a record is kept of the original cost of a piece of work, and the amount of time that was taken to machine it, fit it, and put it in place. He must see that the machines are kept in repair, and that the workmen do not abuse them. He must have a system of inspection in order to know whether the work is properly done. He must have system in everything; if he doesn't, he is missing one of the greatest aids to success.

Briefly stated, the ideal foreman is one who gets all that is possible out of his men, keeps them contented and at the same time turns out the product of his machines at the lowest possible cost. The nearer a foreman comes to this description, the more valuable he is, and the further from it, the less he is worth. E. VIALL.

Decatur, Ill.

TOOLS FOR MOTOR CAR CYLINDER BORING.

The set of tools shown in the accompanying illustrations is used in a horizontal boring machine for motor car cylinder boring. These tools were designed by the superintendent of a large motor car factory in England. In Fig. 1 is shown a device for boring the two cylinders of an engine at one setting. A 6-pitch gear is mounted on the flange of the boring machine spindle. This gear meshes into gears on the spindles of the boring fixture. The spindles run in phosphor-bronze bushings, and the thrust is taken at the end by a ball bearing.

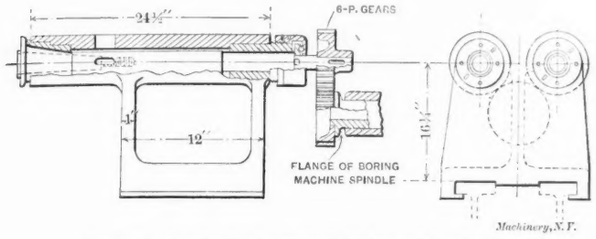


Fig. 1. Device for Boring Two Cylinders at One Setting.

The fixture has slots cut through at the front end to facilitate the removal of cutters, etc. This permits the spindle to be solid back of the hole for the taper shank of the tools used. The front end of the spindle bearing is tapered, and the back bearing is parallel. The fixture is held to the boring machine by straps. In Fig. 2 is shown the boring head. This has a tapered hole for the arbor, tapering ⅛ inch per foot. The rear end of the head is slotted for a key drive, and the front end is counterbored and a collar is placed in the recess secured to the arbor by a collar-head screw. This makes a firm and strong drive. Three Novo steel cutters are used in the head

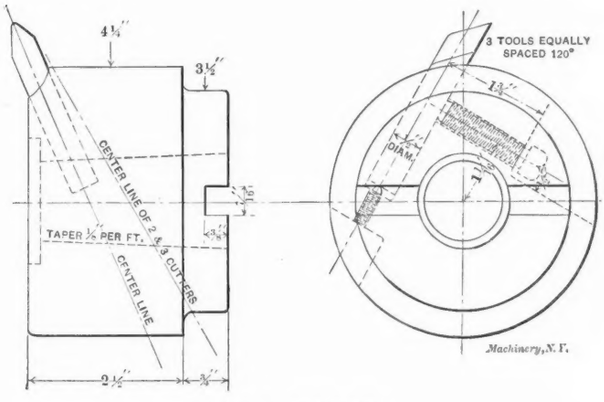


Fig. 2. Boring Head.

and are spaced 120 degrees apart, but are placed on two different centers in order not to weaken the head too much. The cutters are adjusted by small headless setscrews and are clamped in place by ⅜-inch square head screws, as shown. Two cuts are taken through the cylinders, the chips being blown out by compressed air.

In Fig. 3 is shown a facing tool holder. The facing tools are subjected to very heavy duty and must be held steadily. The hole in this holder is straight. On one end it is slightly countersunk on a 45-degree taper, and on the other side recessed to a 2-inch diameter for the spindle flange. Two keys are inserted into keyways on the spindle flange, making a positive drive. Flat tools of high speed steel are fitted into the slots in the head and are countersunk for the binding screws, so that when the screws are tightened, the cutters are brought down tightly against the back of the holders. These tools are nicked on the cutting edge in order to break up the chips. A steady rest which is used when facing the cylinders is shown in Fig. 4. The 1¾-inch diameter passes through the hole in the facing tool holder, and the ⅞-inch threaded part on the end screws into a threaded hole in the spindle. The 45-degree beveled face bears up against the 45-degree countersink, just mentioned, in the facing tool holder, and forces this

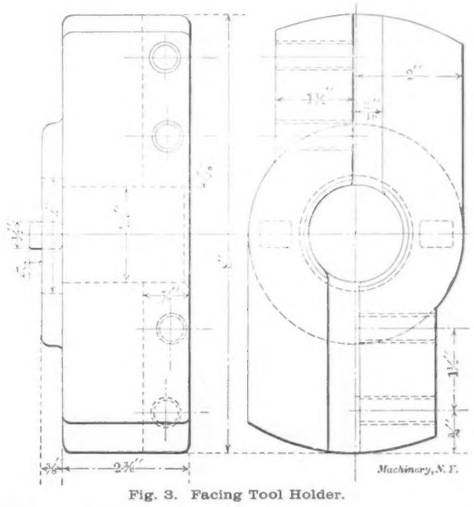


Fig. 3. Facing Tool Holder.

holder up against the flange of the spindle nose. The steady rest proper is made of cast iron and turned 0.002 inch smaller than the diameter of the cylinder. A felt washer is placed behind the cylindrical rest to permit it to give slightly.

In Fig. 5 is shown a valve boring and facing tool. The cutters for this are circular and keyed to the arbor. The pilot at the end enters into the hole already drilled for the

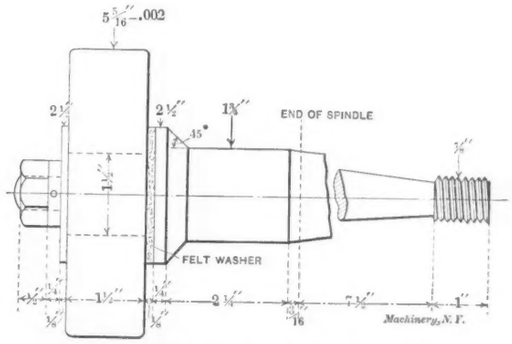
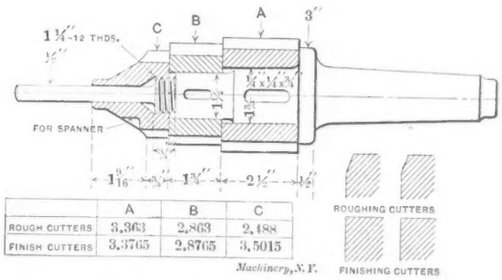


Fig. 4. Steady Rest used when Facing Cylinders.

valve spindle. In order to save space the end cutter is also made to act as a nut, and gashed for a spanner wrench. Two cutters are used for finishing the bore, one roughing and one finishing.

In Fig. 6 is shown a recessing tool which is used for recessing the groove shown at *A* in Fig. 7. A heavy center spindle which has a keyway and key in its upper portion, and then turned down to a smaller diameter, is milled at the lower end



	A	B	C
ROUGH CUTTERS	3.363	2.863	2.488
FINISH CUTTERS	3.3765	2.8765	3.5015

Fig. 5. Valve Boring and Facing Tool.

for a tool *D*, which is made of high speed steel and formed to the shape required. This tool is drilled for pivot *F* and slotted for pin *E*, which latter is milled flat on the sides. The stud *E* moves endwise in the slot in *D* until collar *B*, which acts as stop, comes up against bushing *C*. This bushing guides the tool and spindle in the cylinder and is beveled at the end

so as to easily enter the hole. The spring inside of the bushing allows the cutter to recede when the arbor is removed from the cylinder. BORER.

R. S.'S PERPETUAL MOTION EXPOSED.

In the July issue of MACHINERY, R. S. claims to have solved the problem of perpetual motion, but I regret to say that although it may prove financially a success—people have been known to subscribe for stock in things lots more foolish than this—his device will not be the motive power for very many factories, for the simple reason that it will not work. While it is one of the best perpetual motion devices on the market, it is easy enough to prove that there will neither be a perpetual motion, nor even a temporary motion, except if caused by outside forces. This, of course, we all know, but an explanation why R. S.'s machine does not work may nevertheless be in place.

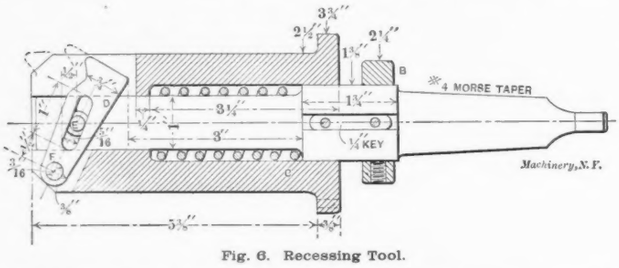


Fig. 6. Recessing Tool.

The explanation is simply this, that the work performed by the device when the leaden weights fall down and pull out the bags, thereby pushing the water aside, equals the work afterward done by the water on the bags. The water cannot be displaced without expenditure of energy, and the apparent gain of energy, as explained by R. S., is exactly equalized by the loss of energy due to displacing the water when the leaden weights pull out the bags. This can be exemplified by referring to the action of a cylinder in a piston under analogous circumstances. Suppose a piston and a cylinder of the same specific gravity as water were submerged in water to a depth of 10 feet. Assume the area of the piston to be 4.608 square inches. Then, a six-inch movement of the piston will displace 27.648 cubic inches of water, which weighs one pound, taking the weight of water to be 62.5 pounds per cubic foot. At a depth of 10 feet the hydraulic pressure will be 4.34 pounds per square inch. Consequently, the work done in pulling out the piston six inches and displacing one pound of water will be:

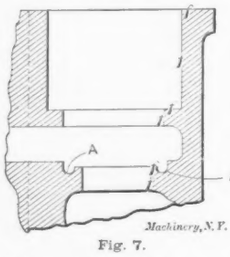


Fig. 7.

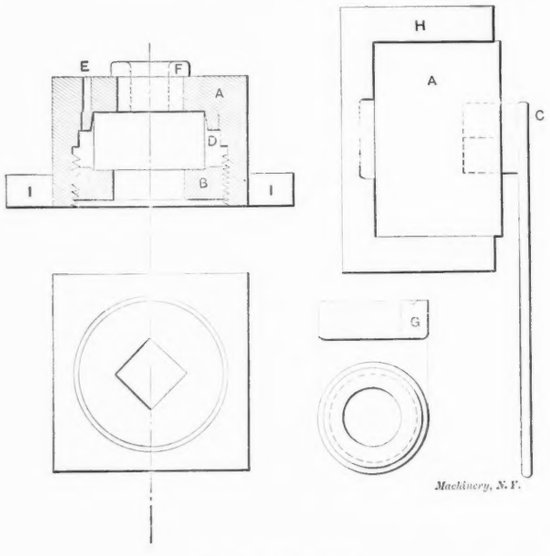
$$4.34 \times 4.608 \times 6/12 = 10 \text{ foot-pounds.}$$

The piston and cylinder have, however, acquired a buoyancy of one pound, and in traversing 10 feet to the surface the work of lifting would be equal to 10 foot-pounds, or the exact equivalent of the work required to pull out the piston and create the buoyancy effect. N. MEYER.

New York.

INTERCHANGEABLE JIGS FOR DRILLING COLLARS.

The article in the June issue of machinery by Geo. T. Coles regarding the making of collars under the steam hammer, reminded me of the methods I adopted in the machine shop some time ago to reduce the cost and increase the output of a variety of sizes of collars. These collars are made of annealed tool steel in sizes varying in thickness as well as in diameter and size of hole. They are cut off on a cold saw by a boy who attends three machines. They were previously made from the bar in a monitor lathe, and the cost was far in excess of what it ought to be. Having a three-spindle gang drill in the shop, which was idle part of the time, I therefore decided to make use of it in the production of these collars. Four jigs like the one shown in the cut were made. They were made to take any diameter or thickness of collars within their range. The body of the jig is a square block of steel, with the hole to receive the collars exactly in the center. The lower end is threaded left-hand to receive piece *B*, which has a square hole in the center to receive wrench *C*. The ring *D* is bored taper, and fits the collar operated upon at the top end only, so that the collars will drop out of the jig easily. The rings are made to fit collars of different diameters, and are just an easy drive fit in *A*, the body of the jig. They are driven out with a soft punch through holes *E* in piece *A*. Drill bushings *F* are also interchangeable. Piece *G* is a distance piece used when drilling thin collars in order to avoid screwing piece *B* into the jig too far. It is apparent from the cut that these pieces are made to fit the collar at one end, and beveled at the other to center in piece *B*. The reason piece *B* is threaded left-hand is as follows: If the collar operated upon should turn in the jig, the piece *B*, taking the thrust, would also turn, and being threaded left-hand would thereby tighten the collar in the jig. Piece *H* is a channel iron the function of which is to hold the jigs while refilling. In operation, one of the jigs is placed upon the drill



Jig for Drilling Collars.

press table under each spindle between flat strips *I*, which keep the jigs from turning, at the same time leaving them free to be removed for refilling. It will be seen that by having four jigs, and a three-spindle machine, by timing them so that they will finish the holes one after the other, it will give plenty of time to refill the fourth jig, and thereby, with an extra drill or two, kept sharpened by the tool grinder, the machine may be kept in constant operation. This machine is equipped with a pump keeping a constant flow of cutting fluid on the drills. As this machine is also handled by comparatively cheap labor, a saving of almost 400 per cent was shown by actual test. C. G. H.

SOME AUTOMOBILE FACTORY WRINKLES.

A simple and effective method of finishing the big end bearings of the connecting-rods of gasoline automobile motors is in use at the factory of the Locomobile Company of America, at Bridgeport, Conn. The rods, which are of drop-forged steel, heat-treated, are bushed at the wrist-pin ends with solid bushings of hardened steel and the split big ends are lined with Parsons' white brass. Heretofore the custom at this factory has been to bore the big end bearings as accurately as possible in special boring machines and then fit each to its individual crank-pin by hand, with the aid of the scraper. The new method, which saves time in turning out the work and also makes a better job, consists in boring the bearing a few thousandths small, and then forcing through it a tapered mandrel of hardened and highly finished steel, the largest part of the mandrel being of course of the size required for the finished bearing. The mandrel is forced

through the bearing by means of a hand-press whose plunger is depressed and raised by a rack-and-pinion arrangement, worked through a ratchet by a hand lever. The mandrel is passed through twice, from opposite sides of the rod. At the completion of the operation the metal is somewhat compressed near the surface and is very highly polished, having a glaze such as it would acquire after running for some time in actual service under favorable conditions. The bearing is a very good fit on its crank-pin, and no hand fitting whatever is required, so that the polished surface is not broken. The compression of the metal, together with the glaze on its surface, apparently increases its ability to resist wear. Preliminary tests showed that bearings finished in this way would wear considerably less than carefully hand-fitted bearings run under exactly similar conditions. Of course the crank-pins must be very accurately finished, or the accuracy and high finish of the bearings will be of little benefit. Preparations are being made to finish the main bearings of the crank-shafts in the same way.

At the same factory the idea of giving new parts the same finish that is acquired by running under proper conditions is carried out in finishing the piston rings, which in a high-compression gasoline engine must be as well fitted as possible. After being finished on grinding machines, the rings are put into a holder which corresponds to the piston and holds the rings just as a piston does, and this is worked to and fro in a cast-iron tube bored and finished exactly the same as a cylinder of the motor, a small quantity of a fine abrasive substance being employed. The rings so finished bear all round when placed in their own cylinders, and also bear right across from edge to edge. The piston is tight from the first, and wears very well. Of course the tubes used in the finishing process are subjected to considerable wear and must be renewed frequently; but this is found to be a very unimportant detail as compared with the excellent results obtained by the employment of the process.

An interesting detail, which would probably not present itself to the mind of the average man, is that piston rings, after being ground on a magnetic chuck—a very widely used method in automobile shops—are more or less highly magnetized, and if allowed to go into the engine in this condition they will attract and retain any small particles of iron or steel that come near them, with unfavorable results in the matter of wear. Consequently it has been found necessary, in the factory in question, to install a demagnetizing apparatus which effectually removes this cause of trouble. HOWARD GREENE.

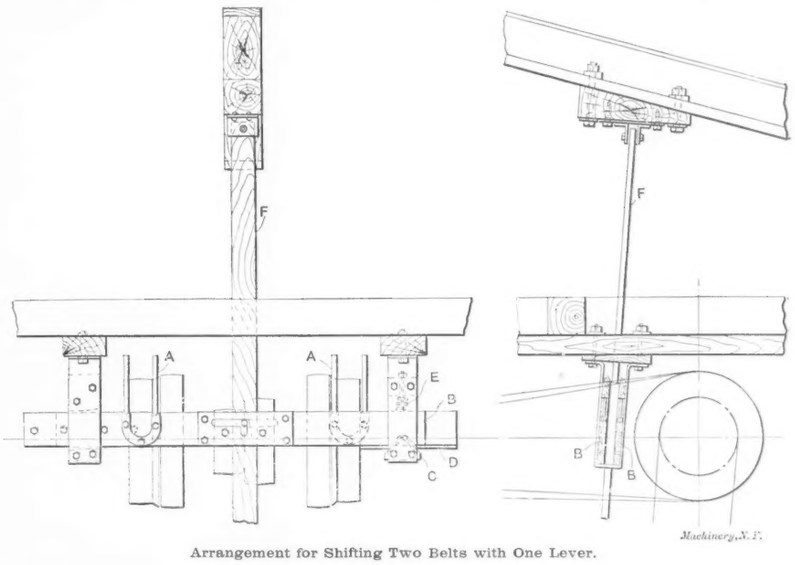
SHIFTING TWO BELTS WITH ONE LEVER.

The cut herewith shows a design for shifting two belts with one lever, which I think might be of interest to some of the readers of MACHINERY. The belt shifter fingers *A* are bolted to the sliding bars *B*. These bars are carried in the supports *C*. The bars have notches cut in one end. These notches are faced with the steel shoe *D*. The notches fit over corresponding wedge shaped blocks in the right-hand support, and are held down on them by the spiral springs *E*. The shifter lever of the machine is between the two sliding bars and carries a pin that works in a slot in the sliding bars. The bars are strengthened by the steel plates in their middle portion as shown. The action of the device is as follows. When the shifter lever *E* of the machine is in the position shown, both belts are on the loose pulleys. If the lever is moved to the right, the sliding bar nearest to the operator moves to the right, and the notches ride up on the wedge shaped blocks, lifting one end and causing the pin in the shifter lever to slide into the vertical slot in the bar. In the meantime the pin on the opposite side of the shifter lever has moved through the horizontal slot in that bar, shown by the dotted lines, without moving the belt shifter fingers on that bar. When the shifter lever is returned to the central position, it shifts the belt of the bar, nearest to the operator, to the loose pulley, because the pin is now working in the vertical slot. Continued motion of the lever to the left will cause the same operation to be repeated with the other shifter bar. Stops in the left hand portion of the bars keep them from moving too far to the right or left. This shifter has been working in the shop where it was made for some time, and has not given any trouble.

Norristown, Pa. WILLIAM L. AMBLER.

OBTAINING ANGULAR MOVEMENTS WITH THE INDEXING HEAD.

In the February, 1907, issue of MACHINERY appeared a table giving the movements of the indexing head of a milling machine for a series of angular measurements in degrees. The



Machinery, N. Y.

Arrangement for Shifting Two Belts with One Lever.

explanation of how to obtain the movement corresponding to a certain number of degrees did not seem as plain to me as it could have been made. I therefore present the following, in order to make the relationship between the movements of the index head and the angular movements as clear as possible.

As a matter of fact, we can obtain in the first place any movement in whole degrees, since the indexing of 360 is obtainable by simple plain indexing on any of the standard heads. This division is made by taking two holes in an 18-hole circle. Should it be desired to index, say, 27 degrees, we would multiply 27 by 2 and obtain the number of holes necessary for such a movement. As 54 is a greater number than the number of holes in the circle, we would have as the movement of the index crank $54/18 = 3$ turns to make a 27 degrees division or indexing. Half degrees are obviously obtainable from the same source; as it requires a two-hole movement for a whole degree, it would be necessary to make but a one-hole movement to obtain the half degree. By substituting the 27-hole circle we may obtain a division of 20 minutes for a movement of each hole. Any row of holes that is divisible by 9 will give divisions of degrees and fractions thereof. Thus a 54-hole circle will give divisions as low as 10 minutes or one-sixth of a degree. This plate is furnished on some heads. By means of the differential index we may still further split up the fractions of a degree, but quarters or sixths of a degree are pretty close, and should be fine enough for even the closest jig work. Of course there are some jobs that one would encounter that might possibly call for much finer divisions, but they would then have to be accomplished by some other means than the one just considered. The above is by no means new, but was suggested by the table mentioned above.

The universal milling machine has become quite a factor in the production of small jig work, and is very handy on such work. When properly adjusted and carefully used, very accurate results may be obtained by its use. However, good

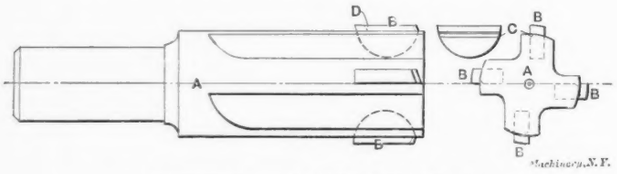
results must not be assumed to be possible from a machine that has been abused, and which is out of true; nevertheless, many unreasonable people think that they ought to be able to do so. Then, again, what is the limit that we may put on the accuracy of such machines? They are certainly far from being perfect even when just out of the inspector's hands. There is a tendency for some fussy individuals to split thousandths to an exaggerated degree even in the plain machines used in manufacturing. This is wandering some from my original topic, but it may be well worth saying.

Hyde Park, Mass. JOHN EDGAR.

INEXPENSIVE TOOLS WITH INSERTED HIGH-SPEED CUTTERS.

We are at the present time in need of cutting tools out of high speed steel, and we would make them of this material if the price of the steel were not prohibitive in a good many cases. To overcome the objection of cost I have adopted a principle by means of which high speed tools can be made at a small fraction of the cost of solid tools. The principle is plainly shown in the cut, in which *A* is the body of a four-lip drill, made out of soft steel, and *B*, half-round disks inserted at the end of the flutes for cutters. The manner of inserting the blades is similar in principle to the Woodruff key system. The cutters *B* are cut off from round high speed steel bars, which have been turned to the exact diameter of the cutter, and are then split in halves with a hacksaw because of the stock saved by using this tool in preference to a saw in a milling machine. The cutters must be made to fit close in the milled slots, and for final binding a notch *C* is filed lengthwise in the cutters about the same height, or slightly below, the outside diameter of the body *A*. When the cutters are hardened and driven home, the soft metal of the body *A* is forced into the notch *C*.

The grinding and relieving is made in the same way as with a solid drill. When the cutters are ground back to about the distance shown by the dotted lines at *D*, the cutters are driven out and new ones inserted. This drill answers admirably for turret work where a boring tool follows



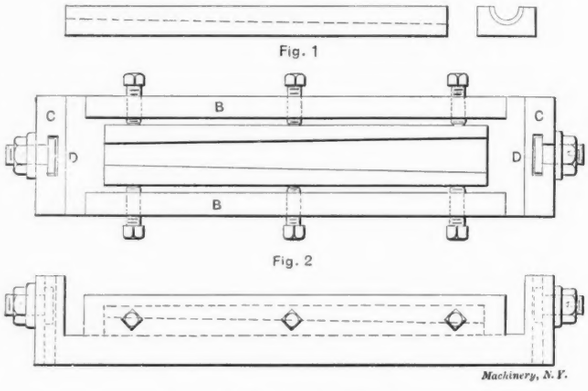
Inexpensive Inserted Blade Four-flute Drill.

for truing up the hole. For drill-press work another set of cutters can be set in back of the first set, so that when the first set of cutters is partly ground away, the second set will steady the drill. The same principle applied to a boring bar has several advantages, as there can be more than two cutting points put in the bar without materially weakening the bar, as is usually the case in small bars with the customary flat cutter and a slot through the bar. Coarser feed can then be used than with a two-point cutter. Another advantage is that on account of the small size of the cutters, it is possible to harden them very hard without risk of breakage, which would hardly be possible with drills of the larger sizes. The tools mentioned have been made, and have given perfect satisfaction, and there is no reason why this principle can not be applied to numerous other tools such as counterbores, milling cutters, and large reamers.

Lawrence, Mass. CHARLES THIEL.

FIXTURE FOR PLANING CONCAVE TAPERS.

Some time ago we had to make a number of semi-circular concave steel pieces as shown in Fig. 1, as well as quarter-circular concave pieces. These pieces were to be made so that if four quarter-circular or two semi-circular pieces were put together, they would form a round taper hole, the large end of which was to be 1¾ inch in diameter, and the small end ⅞ inch in diameter. The extreme length of these pieces was 32 inches. They had to be made very accurate, and when put together must show a good fit on a tapered arbor. In order to plane these pieces a simple fixture was made, as shown in Fig. 2. The body of the device was a casting 40 inches long and 4½ inches wide with two ribs *B B* and uprights *C C* at the ends. In these uprights two vertical T-slots were cored. The body was planed on the bottom between the ribs, and a number of holes drilled and tapped in the ribs for set screws to hold the work to be planed. Two 1-inch T-bolts with heads to fit in the T-slots *D D* were turned and threaded. The bolts were provided with very large centers in the threaded ends. These bolts were placed in the T-slots, a heavy washer slipped on, and the whole fastened by a nut. The steel pieces to be planed concave were now marked on the ends with their respective radii, and fastened by means of set screws in the fixture. The dividing heads were placed on the planer bed with the fixture between centers, the centers of the dividing head entering into the centers of the T-bolts. Then the fixture was adjusted between the centers. The T-bolts were set so that when the fixture was swung around, the radii at both the large and small ends would conform with the surface gage needle. The nuts and



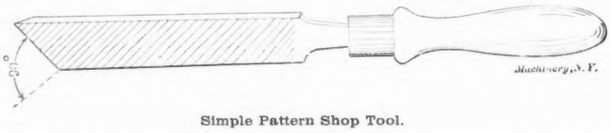
Fixture for Planing Concave Tapers.

T-bolts were then tightened. Now the end of the large radius was raised to the amount of the difference between the small and large radius, by adjusting the foot-stock end of the dividing head, and the work was ready to be planed. It will be seen that when turning the work between the centers, very accurate work could be done, and almost any taper within the range of the fixture could be planed. For final finish in this particular case the planed pieces were only rubbed with emery cloth, and when the pieces were put together and the tapered mandrel put in, they showed as good a fit as could be wished for. The fixture was inexpensive, and could be utilized for a good many other purposes. JULIUS F. A. VOGT.

Buffalo, N. Y.

SIMPLE PATTERN SHOP TOOL.

In most every pattern-shop there is more or less repairing and altering on old patterns, and to the average mechanic it is not very pleasant work on account of the destructive action on the tools. Turning an old pattern that is full of sand is one of the many disgusting jobs that come up. It is almost impossible to get a turning tool that will remove the surface or, as I might call it, the scale. For this class of turning I



Simple Pattern Shop Tool.

have two turning tools, made right and left, from flat, single cut files. The end is ground at right angles to the cut or tooth of the file, as shown in the cut, care being taken so as not to draw the temper in grinding. An old file will answer the purpose, but a new file is worth half a dozen old ones. Pattern-makers and millrights know what a job it is to turn an old or new split wood pulley. This tool will do the job easily. MILLWRIGHT.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

CUTTING FIBER.

In a number of factories where I have been employed, fiber was used in the manufacture, and the cutting was done in the pattern-shop, either on the band saw or circular saw, destroying the cutting edge in a very short time. If rotary shears are at hand the work of cutting fiber into strips of any length and width can be done with ease, and accurately as to measurements, without in the least injuring the cutters. The edges are left clean as if cut with a sharp tool. A pattern-maker will excuse a nail cut into once in a while, but never the cutting of fiber. P. M.

TO PREVENT LEAD PENCIL FROM BREAKING.

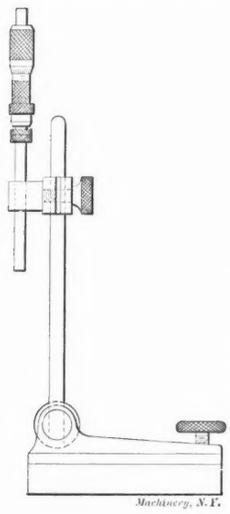
A small shell partly filled with a piece of lead, steel or shot, and forced on the end of a drawing pencil, may appear

Machinery, N.Y.

to be a queer contrivance; but this end being the heaviest will naturally fall to the floor first, and will prevent the lead from breaking. GORDON F. MONAHAN.

Bridgeport, Conn.

INSIDE MICROMETER FOR SETTING CALIPERS.



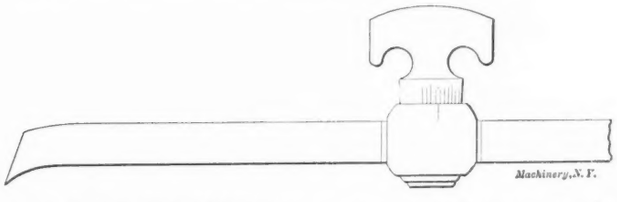
Machinery, N.Y.

The cut herewith shows an application of inside micrometers which is very handy. The hole for the scriber in the scriber clamp of a surface gage is reamed out to fit the rods used with inside micrometers. This forms a convenient holder for the micrometer when used for setting outside calipers to it. The calipers can be set easily and accurately at the same time, and where extreme accuracy is not necessary this arrangement is more handy than that of using large-sized micrometers. The writer has found that an accuracy of within one-quarter of 0.001 inch is obtainable in this way. Mistakes, in fact, are more easily guarded against than is the case when using the micrometers directly.

SIRIUS.

GRADUATED STOP-COCK FOR OIL.

Having much fine planing to do on the milling machine, for which a very close regulation oil was necessary, one of our fellows conceived the idea of the graduated oil-cock, shown in the cut, which enabled him to regulate the flow



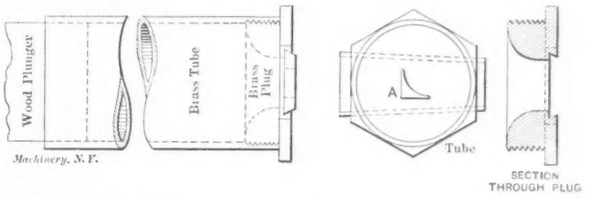
Machinery, N.Y.

very closely and without the usual "turn and try." As the nature of the work was such that he could only continue at it intermittently, he would close the cock entirely when necessary to stop, and upon resuming would open it full for an instant to fill that portion of the pipe between the cock and outer end, and then turn to that graduation, which he would remember had before given the proper flow.

Springfield, Ohio. A. B. CHRISTMAN.

TOOL FOR SHAPING WAX FILLETS.

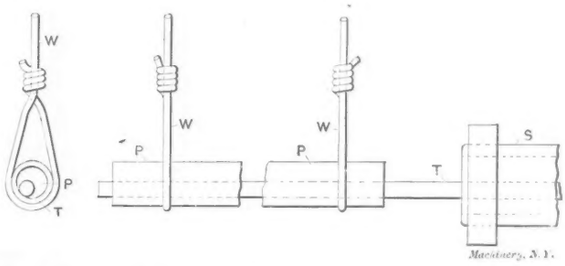
In the cut is shown a wax fillet tool that shapes the wax to a correct fillet instead of round as in all others that I have seen or read of. The brass tube is 1¼ x 8 inches, threaded at one end to receive a brass plug. This plug has a dovetail cut in it, as shown in the detailed view. In this



dovetail may be fitted brass plates, as many as are required for the various sizes of fillets. These are cut out as shown at *A*. By placing the fillet plate required in the brass plug, and heating the tube in the regular way, a much better fillet is made than with the round wax. PATTERN-MAKER.

STOCK SUPPORT FOR SCREW MACHINE.

Probably not one screw machine in a thousand has a stock support arranged as is the one shown in the cut, but for light stock it has advantages in the matter of economy of

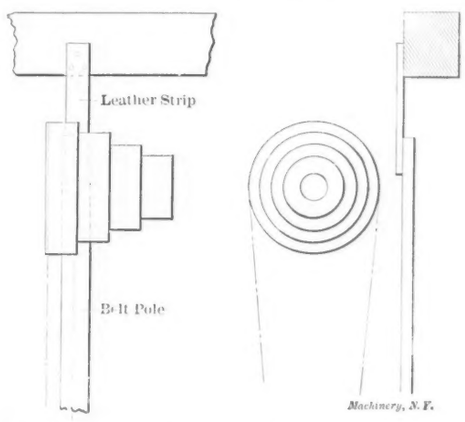


floor space, and can be swung up out of the way occasionally. In the cut, *S* is the spindle of a screw machine; *P*, a pipe; *W*, wires suspended from the ceiling, and *T* the screw-stock.

Springfield, Ohio. A. B. CHRISTMAN.

BELT SHIFTER.

The cut herewith shows a handy and cheaply made belt shifter for the lathe or milling machine. It consists simply of a stick fastened to a beam by a strip of leather, about midway between the two largest steps of the countershaft



cone. In shifting the belt, the operator reaches through the belt and, grasping the stick, pulls it around against the belt to shift it to the desired step of the cone. For medium size cone pulleys the strip of leather which is fastened to the ceiling and to the stick should be 10 to 15 inches long, of single thickness, and about 2½ inches wide. The pole is hung about 1½ inch back of the largest diameter of the cone pulley. This shifter does away with the need of going after the usual belt pole. When correctly hung, it will shift the belt the whole length of the countershaft pulley. It is used quite extensively in the shops of the W. P. Davis Machine Co., Rochester, N. Y. C. SHAW.

Detroit, Mich.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

BECKER-BRAINARD UNIVERSAL INDEX AND SPIRAL HEAD.

The design of this head is the result of a desire to fill the need for a device that will answer the requirements of the heavier duty now imposed on the milling machine, and still retain the accuracy expected from such a tool. It has also been attempted to retain all the conveniences found in older designs of spiral head, and to add to these others that will increase the usefulness and convenience of the tool.

The prime considerations have been those of stiffness and accuracy. The spindle and worm-wheel are supported in a

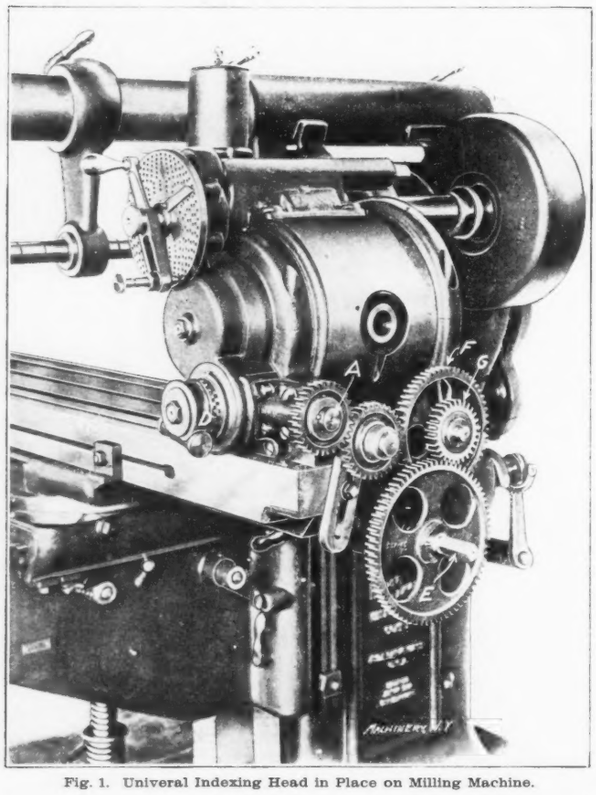


Fig. 1. Univeral Indexing Head in Place on Milling Machine.

heavy block housed between two rigid uprights, in which the block swings in a vertical plane. Any angular adjustment required may be firmly held by tightening the nuts on clamping studs *M M* (see Fig. 6), which draw the outside plates securely against the uprights, making a rigid fastening for the head under the heaviest cuts, even when the work is not otherwise supported. The increase in strength thus obtained has in no way impaired the ease of handling.

The leading feature of the design so far as accuracy is concerned, is the large size of the worm-wheel which has been obtained. This is the largest that the respective swing of each size of head will allow, and the arrangement of the parts is such that in each case it is larger than that of any other head so far offered. Fig. 2, showing the back plate removed, gives a good idea of the unusual diameter of the dividing wheel. This adds greatly to the life of the worm and wheel teeth, as well as to the accuracy, since the wear due to the strain imposed by spiral milling is perceptibly reduced. The coarse pitch it is possible to use with the usual 40 teeth in a dividing wheel also allows of stronger gearing. Another feature is a provision for taking up wear in the worm and worm-gear so as to do away with all inaccuracies due to back lash. The worm gear, as may be seen in Fig. 6, is made in two sections, one of which may be rotated on the other to take up the wear. This method has long been used, and is a most accurate arrangement for making the required adjustment.

Elaborate provision is made for differential indexing. Unlike the arrangements commonly employed, this design provides for differential indexing under the following conditions: with the head in any position on the machine platen, with the work spindle at any angle with the cutter arbor; with work such as bevel gears, having conical surfaces instead of cylindrical; and in cutting helical grooves such as required in spiral gears, for instance. For all these conditions the full range of plain and differential indexing may be employed. Figs. 4 and 6 show best how this is accomplished. The change gears used in differential indexing are mounted on the rear side of the head, as shown in Fig. 4. As will be seen, they have no connection with the table at all, as is the case with ordinary index heads fitted for differential indexing. Shaft *B* carries on one end a gear meshing with the dial driving gear and on its other end the first of the train of change gears used, these being connected with stud *C* in the rear cover plate of the dividing head. Stud *C* carries on its interior end a bevel gear meshing with bevel teeth cut on the hub of the index wheel. It will be seen that this gearing connects the dial with the spindle in such a way as to give it a differential movement, of any degree required for the desired indexing. This is done in such a way as to make it possible to swing the spindle into any angular position desired, since the gears are all mounted on the swinging head.

To make the differential indexing universally applicable to helical work as well as to straight, was another problem this head has been designed to solve. The cutting of spirals makes it necessary that the plate be geared to the lead screw by suitable change gears. The connection between the lead screw and the index plate must be broken when making divisions, in order that the index plate may be free to make the differential movement with the index crank. This breaking of the connection is accomplished by means of an adjustable clutch (shown at *D* in Figs. 1, 3 and 6), which is withdrawn during the indexing operation. After the division has been made, the teeth in the clutch will be found to be in such a position in

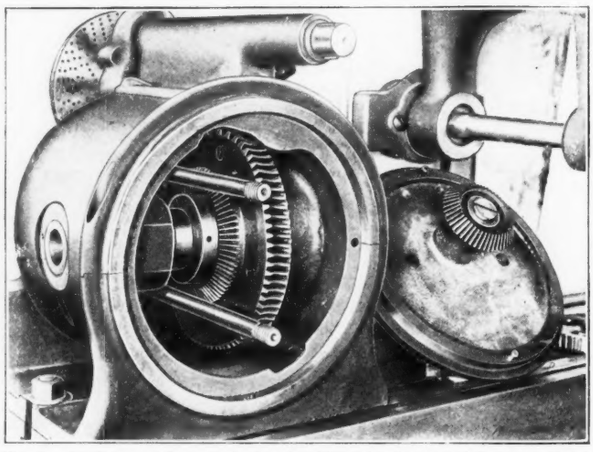


Fig. 2. Back Cover Removed, showing Clamping Bolts and Dividing Head.

relation to the corresponding spaces of its mate that it is impossible to engage them. In order to bring the teeth and spaces opposite each other, half of the clutch is made adjustable, so that it may be rotated the required amount to bring the two portions into proper position for engagement. To effect this, one member of the clutch is connected to its shaft adjustably, by a worm meshing with a worm-wheel keyed to the shaft. This worm may be operated by hand by the knurled knobs shown. When these knobs are rotated, the clutch is slowly adjusted about its shaft, though still positively connected with it. By means of this, the lead screw and the indexing dial are again brought into connection with each other, after the indexing, without disturbing the setting of the work. But there is also another difficulty to overcome. The connection between the index crank and the dial through the worm, worm gear, spindle and change gears of the differential mechanism, would form a locked train when the index

pin is in mesh with a hole in the plate; so this must be released during the spiral cutting operation. This is accomplished by means of a knurled knob *H*, see Fig. 3, back of the index plate, which operates a friction clutch, so that the dial may be released from, or connected with, the differential gearing, as may be required. These various provisions make the differential indexing universal throughout the whole range of work of the machine.

Frequently it is desired to roll the work on its axis by a small amount without shifting the dog or loosening the position of the index pin, or sometimes the amount of adjustment may be such that if it is attempted to do it by the crank, the pin will not come exactly over the hole, as is necessary. If the attempt is then made to move both plate and crank in conjunction it will probably be found that the spacing of the holes in which the back pin enters is such that the required

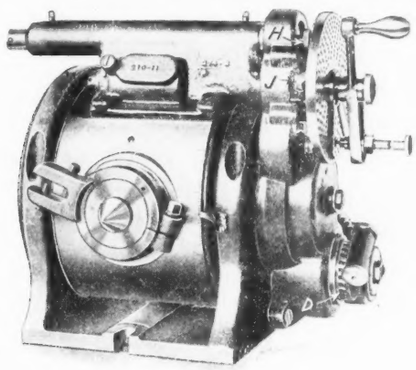


Fig. 3. Front View of Head.

adjustment cannot be exactly obtained. In this head the back pin is done away with, and the plate is held during the plain indexing by a friction clamp on the hub of the plate gear, which is thus gripped or released by a suitable bolt, *J*, conveniently located. By this means work may be set regardless of the position of the plate, which may be securely held in any desired location to bring the work to the position required.

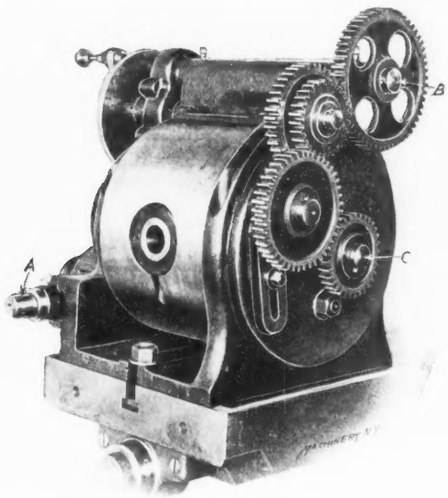


Fig. 4. Back View, showing Differential Gearing.

It is believed that the doing away with the back pin, and the substitution of this more flexible clamping device, will be appreciated by milling machine operators.

Another convenience is an adjustable dial on the spindle nose for obtaining angular divisions directly in degrees, for work requiring no great accuracy. This is much preferable in ordinary cases to the cumbersome method of indexing degrees on the dial plate. A single reversible plate is used for all divisions, it not being necessary to provide a variety of these, with adequate differential indexing.

In recapitulation, the following results have been obtained in this design. It is of stiff and rigid construction, with a large worm and worm-wheel, giving accuracy and durability as well; differential indexing may be accomplished in any position of the head on the platen, on conical work as well as cylindrical work, and in the case of spiral milling; the spindle

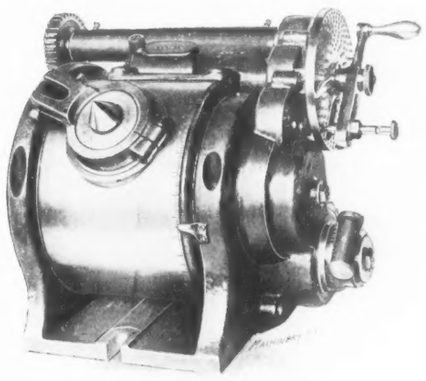


Fig. 5. Head Arranged for Differential Gearing with Angle Adjustment.

and work may be rotated independently of the lead screw when the change gears are set for spiral milling, making the setting of the work easier than would otherwise be the case; means are provided for taking up wear in the worm-gear or dividing wheel; but one reversible index plate is required for all the divisions within the range of the machine, and an adjustable dial is provided on the spindle nose for obtaining

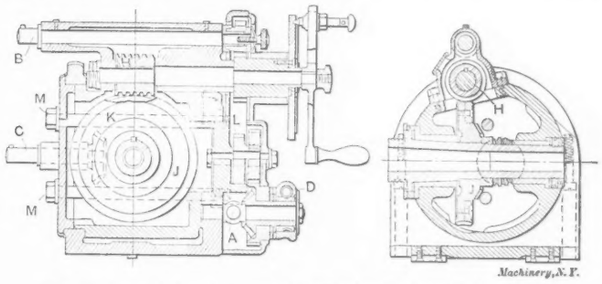


Fig. 6. General Construction of the Becker-Brainard Index Head.

angular divisions directly. This device is furnished with the universal milling machines built by the Becker-Brainard Milling Machine Co. of Hyde Park, Mass.

CUTLER-HAMMER LIFTING MAGNET.

The Cutler-Hammer Clutch Co., Milwaukee, Wis., has been experimenting on the design of electric lifting magnets for some years, in a quiet way. The company has now placed on the market the design illustrated in the three accompanying half-tones. This design is the result of these experiments, and of thorough testing in actual practice in factories, steel works and manufacturing plants.

Like all magnets of this kind, the construction is very simple, being composed of a steel core and frame work with enclosed coils of wire carrying the exciting current. There are a number of features, however, which are original with this design. A concave contact surface has been generally used as being the most efficient for handling loose materials of various kinds, such as punchings, scrap, etc. When, however, this same magnet is to be used for a load consisting of one or two large objects with plane surfaces, this concavity becomes objectionable, since an air gap intervenes between the inner pole and the object to be lifted. To obviate this difficulty an auxiliary pole piece is provided in this design. It is inserted in the concave face of the magnet with a stem passing through the central aperture in the frame. It is so designed that the inner pole is extended downward to the level of the outer pole, thus eliminating the air gap, and insuring intimate contact of both poles with the object to be lifted. The central aperture in which this auxiliary pole is fitted serves another purpose—that of ventilation. In magnets of the usual construction the concave pole face forms an air gap in which heat accumulates very rapidly, and from

which it is difficult for it to escape. The fact that there is a hollow central core through the frame obviates this trouble, making it possible to keep the windings cool at all times. The pole shoe of the magnet is the part subjected to the greatest wear and tear. This is removable, being fastened

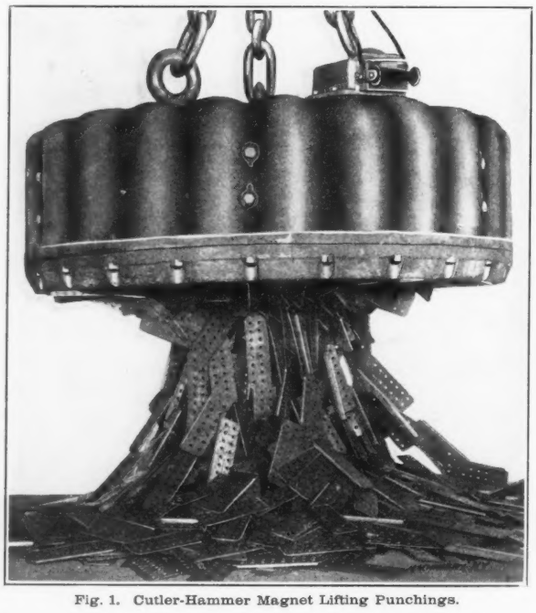


Fig. 1. Cutler-Hammer Magnet Lifting Punchings.

to the under side of the apparatus with through bolts and cap screws.

It will be noticed that the periphery of the frame is corrugated. This is done to furnish a greater radiating surface, and to protect, as well, the heads of the through bolts which fasten the removable pole piece to the magnet frame. The magnetizing coil, on which the efficiency of the magnet depends, is carefully built up of alternating layers of copper and asbestos, and is insulated from the cast steel frame by thick sheets of mica. No combustible material of any kind is used, so there is no danger of damaging the magnet if, by accident, it should be left connected with the circuit over night, as has actually happened. Under test, the coils of these magnets have been heated to 470 degrees F. without injury.

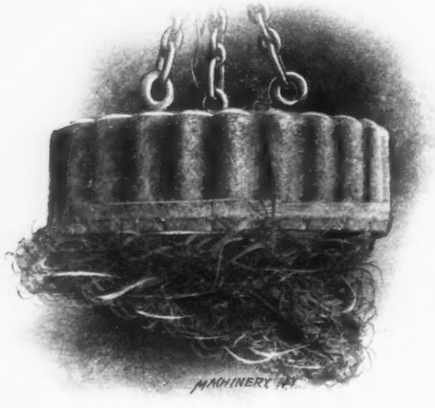


Fig. 2 Fifty-inch Magnet Handling Scrap.

This freedom from injury by heat is also of advantage in lifting and transporting forgings, castings, etc., which are as yet too hot to be touched by hand.

The half-tones shown illustrate two sizes of the Cutler-Hammer lifting magnet. Figs. 1 and 2 show the 50-inch size, and Fig. 3 the 10-inch size. The 50-inch size under favorable circumstances will lift as much as 20,000 pounds. Under other conditions the capacity of the same magnet may drop to 1,000 pounds or even less. This all depends on the nature of the load offered to it. Perhaps as unfavorable conditions as could be imagined were met with in a competition conducted by the Youngstown Steel & Tube Co. This was to determine the best form of lifting magnet for unloading pig iron from cars. The Cutler-Hammer magnet unloaded a steel gondola containing 109,350 pounds of sand cast pig iron in 2 hours 5 minutes. This was done entirely by one man, the crane operator. The average lift was 785 pounds, which was better by 43 per cent than the average made by a heavier competitive magnet. The Cutler-Hammer magnet was purchased and is now in use. The conditions which made this task difficult were the irregular surfaces presented by the sand cast pig iron, and the fact that the material was lifted from a steel gondola.

In Fig. 1, a 50-inch magnet is shown lifting a mass of steel punchings. In this case the auxiliary pole piece mentioned is used. The magnet was not lowered to the punchings, but was brought to within about 3 feet of them, when they arose to meet it as shown in the cut. In Fig. 2, a magnet of the same size is seen lifting plate and sheet scrap of weight not known. This scrap was originally in a pile about 4 or 5 feet high, and was crushed into a compact mass, as shown, by the weight of the magnet. In Fig. 3 the 10-inch size is shown lifting a Bliss car lighting dynamo weighing 800 pounds. The magnet itself weighs about 75 pounds.

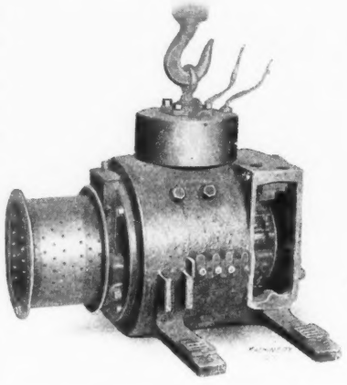


Fig. 3. Ten-inch Magnet Lifting a Weight Ten Times its Own.

The principal points on which the builder claims superiority above all competitors are first, that the weight of a Cutler-Hammer magnet will be guaranteed not to exceed that of any comparable magnet; second, that its lifting capacity will exceed that of any other with which just comparison can be made; and third, that the operating cost per ton of material moved will be less than with any other magnet.

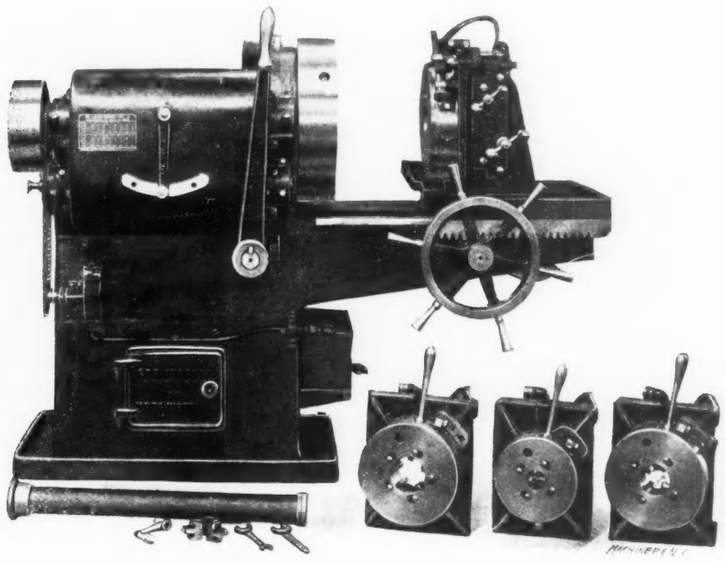
STOEVER LEVER PIPE THREADING MACHINE.

This machine, built by the Stoever Foundry & Mfg. Co., of Myerstown, Pa., is designed to cut off and thread pipe from ¼ inch to 2 inches in diameter, inclusive. As shown in the half-tone, the bed and head-stock are cast together in one piece, insuring a rigid support for the bearings. This is particularly necessary in a machine of this kind, as the operation of the chuck brings a constant strain on the front bearings of the main spindle, which is not properly taken care of where these bearings are in independent castings, bolted to the bed.

The spindle has nine speeds, obtained from a single speed pulley, through sliding gears and clutches. This gives a sufficient range for cutting both steel and iron pipe of the sizes within the capacity of the machine. A speed plate is mounted on the head-stock, showing what speed should be used for each size, so the operator has no excuse for limiting the output through ignorance. The chuck is operated by a lever while the spindle is in motion; but little pressure is required, owing to the design of the linkage employed. The chuck presents a smooth surface, the actual gripping parts being entirely enclosed. Three jaws are provided, adjustable universally at any one of three points on the periphery of the chuck, one of which is within reach no matter in what position the spindle stops. All of the mechanism of the chuck is made of steel. The spindle gearing is completely enclosed, but can be exposed for inspection by removing the cover. A set of bushings is provided for supporting the various sizes of pipe. These extend clear through the spindle, with a bearing at each end, so that there is no trouble on the score of

having to center the pipe to enter the jaws when work is inserted from the rear end. An improved pipe and nipple holder is provided.

The die-head is mounted loosely in horizontal guides on the slide so that it can adapt itself to any eccentricity in the work. These horizontal guides are long enough, also, so that the head can be pushed entirely to one side, in which case the cutting-off tools can be brought very close to the gripping chuck, cutting off work flush with the jaws. In this position, also, pipe can be inserted in the machine from either end equally well, without requiring it to be dragged over the cutting edges of the chasers. A steel cam is used for adjusting the interchangeable steel chasers; hardened steel parts are used throughout in this mechanism to reduce the wear. The front face of the head swings open, so that the chasers may be removed by simply picking them out and inserting others in their place; the whole interior of the head is thus exposed for cleaning or inspection. Two cutting-off tools are used, both being operated by the same handle. A balanced feed is provided, so that both will always be cutting. The machine may be equipped in two different ways, either with a single head and chasers of various pitches, which are changed as the work requires, or with a head and inserted chasers for each pitch. This latter plan, though requiring a more extensive equipment, is the best for jobbing shops, where each operation may be on work of a different size. The length of the horizontal ways in the holder is such that two heads may be mounted at a time, it not being necessary to remove the one in place, if a short job has to be done on another size.



Stoever Lever Pipe Threading Machine.

The oiling system is carefully planned. The pump is driven by a steel chain from the constant-speed pulley. It is of the geared type, and will deliver oil when running in either direction. The oil flows back from the dies and cutting tools to the bed of the machine, and then through strainers into the tank below. The machine is made with a cabinet base in which dies, nipple holders, wrenches, etc., are kept. A large oil pan is also cast around the base. The weight of the belt-driven machine, with one die-head, dies, countershaft and bushings, is 2,500 pounds.

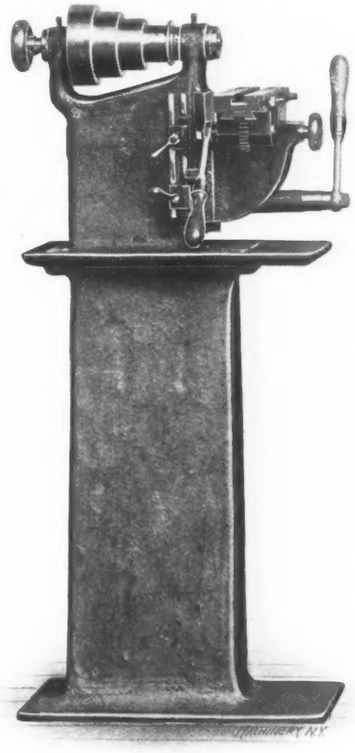
NO. 1 DALIN MILLER.

The hand miller shown in the accompanying half-tone is built by Dalin Bros., Rockford, Ill. It is designed for small work, and is especially adapted to the demands of interchangeable manufacturing, being well built, carefully fitted, and very heavy and rigid for a machine of its size. The table has a long bearing, giving a good wearing surface. The vertical movement of the knee on the column can be limited in either direction by the stops shown, clamped in the T-slot on the side of the column. Fine pitch screws are provided for close adjustments, and the abutting surfaces are so placed as not to be subject to error from the accumulation of chips. Stops are also provided for the traverse of the table. The spindle is regularly fitted with a drawing-in sleeve and a half-inch collet or chuck for straight-shanked arbors and end mills. The machine is driven by a 4-step cone for a 1½-inch belt. If desired, it will be provided with a 3-step cone, and the spindle may be bored to a No. 7 Brown & Sharpe taper if the customer so requires. The machine is sold with or without base.

The height from the table to the center of the spindle is 4⅝ inches. The cross adjustment of the saddle is 2½ inches. The table, which has a working surface of 3½ x 12 inches, has a travel of 7 inches. The weight of the machine, with countershaft and base, is 295 pounds. If required, a vise will be provided, with jaws 1 inch deep, 3½ inches long, and with an extreme opening of 1½ inch.

NEW DESIGN OF THE LO-SWING LATHE.

The accompanying half-tones illustrate changes recently made in the design of the well-known "Lo-Swing" lathe, built by the Fitchburg Machine Works, Fitchburg, Mass. The improvements relate principally to the design of the carriage and tool-holders. The whole machine was described in the November, 1905, issue of MACHINERY. The changes are best seen by referring to Fig. 3, which shows a view of the lathe from above, with the tools operating on a piece of work. Two rigid and compact carriages have been provided, retaining the useful features of the feed mechanism of the previous machines. These carriages are provided with longitudinal ways at the top, on which the tool-holders may be mounted in any position. Two or more of these, if desired, may be used on each carriage, spaced apart by a suitable distance to give the shoulders required on the work. The provision made



Dalin Hand-feed Milling Machine.

for supplying oil to the point of the tool is unique. Oil is conducted to a passage in each carriage by a flexible piping system from the circulating pump. From this passage in the carriage, short sections of flexible tubing are used to supply the lubricant to each individual tool-holder. Plug valves are

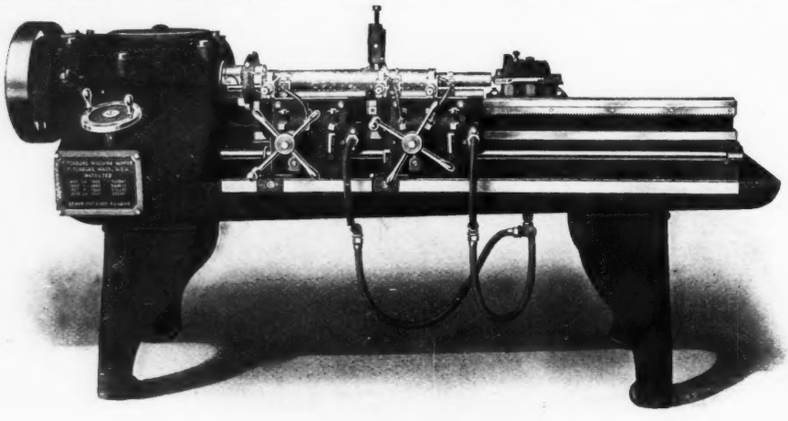


Fig. 1. New Design of Lo-swing Lathe.

provided for each outlet. This arrangement is entirely out of the way, and very convenient.

A new attachment used with this machine provides for the turning of tapers. This is shown in Fig. 2. It consists of a

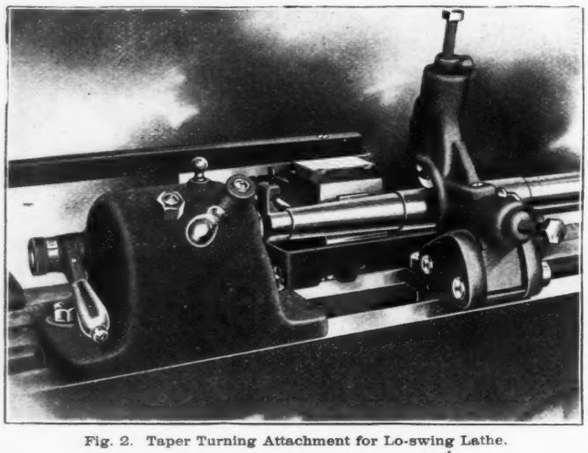


Fig. 2. Taper Turning Attachment for Lo-swing Lathe.

tool-holder with a slide at right angles to the axis of the work, actuated by means of a flat tapered bar or templet, placed directly back of the tool, but fastened to the bed of the lathe so as to always hold the same relation to the work. This templet is planed to half the included angle of the taper desired, and is arranged to be swung out of the way when other cuts are being taken. The taper tool is fitted to receive the follow rest, which on long work precedes the cutting tool, bearing on a previously turned straight furnace. The tool-holder and its guiding frame are easily attached to either carriage, and since it is only ¾ inch wide, ample room is left for several other tools if necessary.

The general plan on which the "Lo-Swing" lathe is designed has been before described, but it may be worth while in this connection to explain it again in a few words. It is built for specialized turning of shafts, pins, studs, forgings, etc., not over 3½ inches in diameter, and with any number of diameters and shoulders. It is designed to do this work with the greatest accuracy obtainable in lathe work. As the work turns on centers, it is readily transferred; so it is used, not only for straight turning, but for any piece on which there is straight or taper turning to do in combination with other special operations, such as threading, chucking, etc. Its advantages for this work are: the fact that several tools may be used at once, provision being made for this by the use of the specially adjustable tool-holders just described; the fact that there is a minimum number of joints between the tool and the bed which supports it, giving the cutting point a very rigid support; and, finally, the machine is designed to furnish convenient means for making rapidly all the changes required, such as altering the adjustment of the tools, changing the feeds, etc.

The decrease in the number of joints and sliding surfaces between the point of the tool and the bed of the machine is especially noticeable. Another point is the fact that the bearing has been brought well under the cutting edge; this could be done on account of the small swing to which the lathe has been restricted. Even when cutting clear down to the center, the overhang of the tool is inappreciable. In the case of an 18 or 20-inch lathe of the usual design, especially if it is furnished with a compound rest, the point of the tool may be anywhere from 8 to 15 inches from the guiding surface of the Vs. There is thus seen to be a great difference between the degree of rigidity obtained in standard lathe design, and in this specialized form for small diameters.

FOSDICK BORING, DRILLING AND MILLING MACHINE.

The machine herewith illustrated is designed for boring, drilling, milling, or tapping, at any angle. It is called by its builders, the Fosdick Machine Tool Co. of Cincinnati, Ohio, their style D horizontal boring, drilling, and milling machine. The machine has a bed plate, tongued and bolted to a main bed, on whose wide upper surface is carried the column, which has a horizontal travel on the ways shown. This column carries the saddle, which is counterbalanced, and can be adjusted by the pilot wheel, or raised and lowered by power. Suitable feeds in either direction are provided for the spindle. These feeds can be used not only for the horizontal travel of the spindle, however, but for the vertical travel of the head on the column, and the horizontal movement of the column on the bed. All these movements can be instantly reversed. The pilot wheel shown can also be used for operating any of these adjustments by hand. These various movements make it pos-

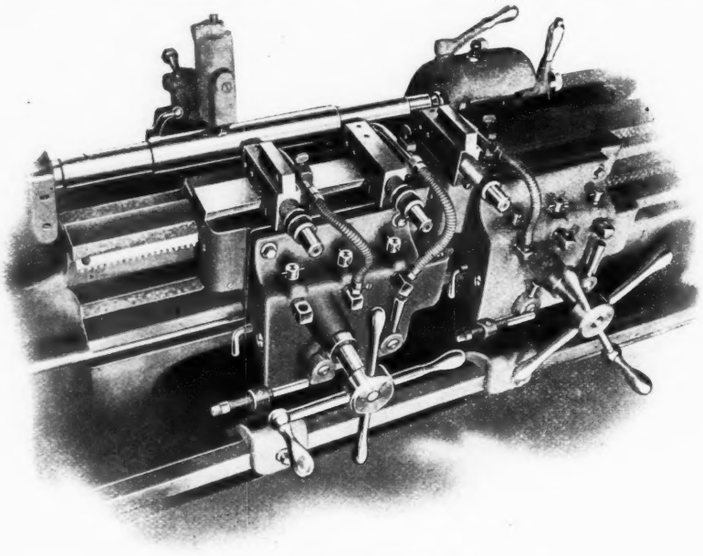
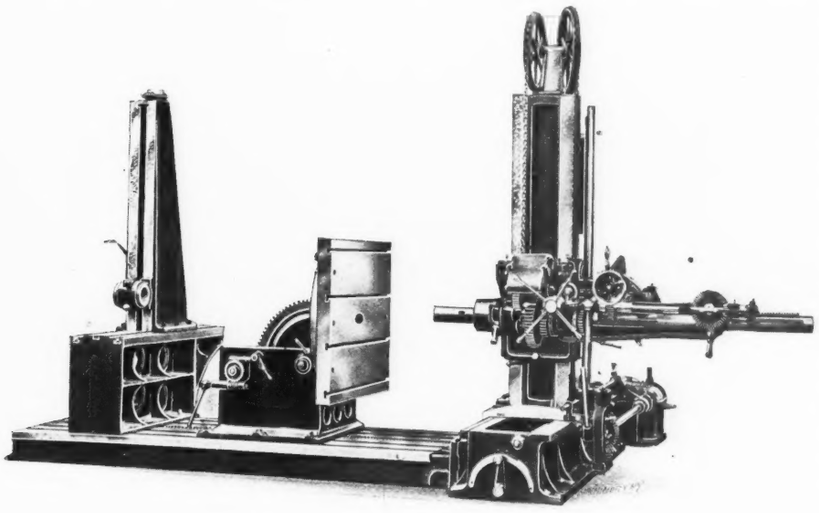


Fig. 3. View showing Carriages and Tool Blocks.

sible to provide power feed for milling in any direction, as well as for drilling and boring. For heavy milling, the column can be fed backward and forward on the bed. This places the strain of the cut on a screw of suitable diameter and

lead, having ball thrust bearings. This feed can be controlled by the lever shown on a semi-circular guide on the front of the machine.

The spindle is connected to a constant speed drive, which can be driven either by a belt or may be geared direct to a constant speed motor. A speed box with positive changes is used, which gives six variations; these may be easily and



Boring, Drilling and Milling Machine with Universal Table.

noiselessly obtained while the spindle is running. This, in combination with the two changes in the head, gives 12 changes of spindle speed of from 4 to 260 revolutions per minute. A friction clutch placed between the back gear and the speed changing device provides for starting, stopping and reversing the movements of the whole machine. This clutch has a toggle friction motion, and is powerful enough to carry the greatest loads it will be called on to sustain. The spindle bearings are of large diameter and length, and are fitted into adjustable taper bronze bushings with provision for taking up wear. The spindle sleeve has a threaded collar of large diameter so arranged that it may be used for securely tightening the spindle bar centrally in any desired position.

The bed plate carries a universal table, which may be swung to present the work at any angle. An outboard bearing is also provided for boring bars. The universal table or the outboard bearing may be moved toward or away from the spindle by a rack and pinion movement, operated by a ratchet. A horizontal movement in the other direction is provided for the outboard bearing through a rack and pinion while the vertical movement is controlled by a crank and screw. All the various movements of the column, spindle, head, outboard bearing, etc., are provided with scales to facilitate setting.

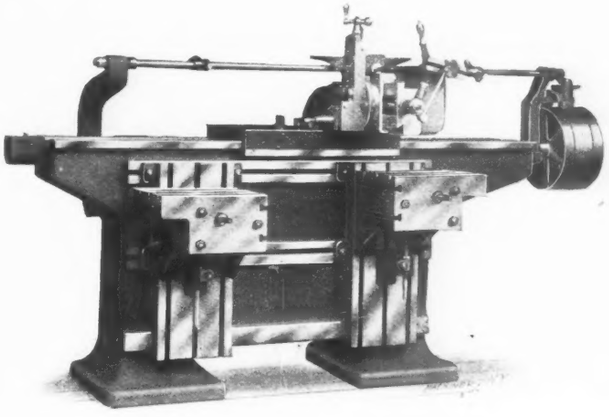
This machine is built regularly in two sizes, of practically the same construction, but with different work holding capacity and traverse of the feeds. The No. 2 machine has a spindle with a No. 6 Morse taper socket and a traverse of 30 inches. The vertical adjustment of the head and column is 54 inches; the horizontal adjustment of the column and the bed is 62 inches. The center of the spindle can be raised to a distance of 72 inches above the base, or lowered to within 22 inches of it. The base is 42 inches wide by 127 inches long, and the universal table has a clamping surface 40 x 46 inches. The total height of the No. 2 machine is 9 feet 6 inches, and the net weight is 20,000 pounds.

CINCINNATI OPEN SIDE SHAPER.

This machine, shown in the accompanying half-tone, is one of a line of which the smallest size was illustrated in the January, 1907, issue of MACHINERY. As there described, these machines are especially adapted to certain classes of work which cannot be easily handled on the ordinary shaper. For instance, there is practically no limit to the diameter of shaft which can be key-seated. The usefulness of the ordinary shaper in this direction is limited by the size of the opening through the column under the ram. Again, it has the advantage of having a uniform deflection for the tool throughout the length of the stroke, the amount of over-hang being constant during that time. In the regular shaper the tool and arm spring upward, and the work deflects downward more at the end of the stroke than it does at the beginning, giving the well-known "fan-tail" cut, which is one of the objections to the shaper for accurate work. The range of the machine is also considerably increased. Castings of great size can be brought up to it and worked on by it without interfering with any portion of the machine.

The size shown in the cut planes 15 inches wide by 60 inches long. The maximum distance from the head to the table is 23¼ inches. There are two tables, each 15¾ inches wide with a vertical adjustment of 19 inches. They are 15 inches deep and rigidly constructed. The use of two of them, independently adjustable, makes it easy to hold irregular work that would otherwise have to be supported on blocking at one end.

The head is traversed by the method adopted by the builders is their previous machine, a bronze nut and steel screw being used, directly keyed to the driving pulleys without the intervention of gears. The reversing action depends on the turning of the shifting rod. This is accomplished by cams on the saddle, coming in contact with



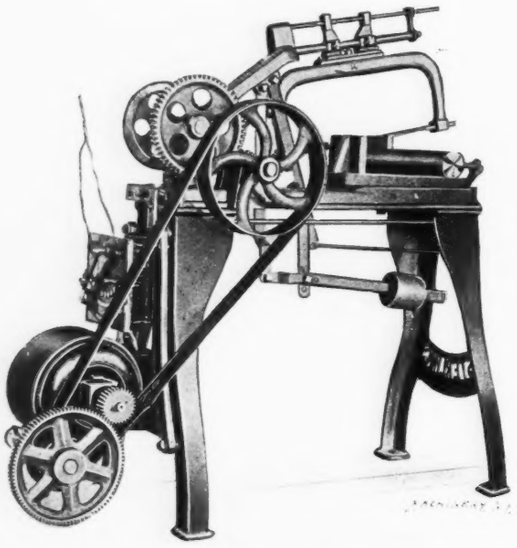
Richards, or Open Side Shaper.

dogs, which may be adjusted to any position of the rod; or the rod may be turned by hand from the saddle if desired. This shifting rod is supported on ball bearings, as are also the elevating screws for the table. This machine is built by the Cincinnati Shaper Co., Cincinnati, Ohio.

STERLING MOTOR DRIVEN HACK-SAW MACHINE.

The hack-saw shown in the cut is built by the Diamond Saw and Stamping Works, Buffalo, N. Y. As shown, arranged for motor drive, it is especially useful in stock rooms and tool and machinery warehouses, where there is no line shaft power available; it is useful also where electrical drive is used for other purposes in the plant. The motor is mounted as a unit with the speed regulating rheostat, on a special base secured to the rear legs of the machine. Either a direct current or an alternating current motor will be supplied. The direct-current motor will be wound for 110 or 220 volts, and under special conditions for 500 volts. The type used provides for slow speed, rigid construction, and a considerable overload capacity. It is entirely dust and moisture proof, and has large oil wells with ring oilers. It is provided with a fiber

pinion and is noiseless in operation. The rheostat provided permits of a regulation of the stroke from 45 per minute for tool steel up to 55, the latter being used for machinery steel and cold rolled shafting. The alternating current motors are supplies for circuits of 110 or 115 volts, with 25, 60, or 133 cycles. They are constant speed self-oiling induction motors,



Sterling Motor-driven Hack-saw.

without brushes or commutators. Although they are designed for single phase currents, they may be run between two branches of a three-phase installation.

These machines have a special attachment by which long bars of angle iron or other kinds of stock may be cut off at an angle of 45 degrees or more, if desired. These machines are built in lots of 200 each, so that the manufacturers are able to take advantage of improved methods of producing them economically, giving the producer the advantage of a good machine at a comparatively low cost.

RADIUS MICROMETER.

The accompanying illustrations, Figs. 1 and 2, show two forms of a neat measuring instrument devised by Mr. W. A. Farrar, Whitman, Mass., which he names "radius micrometer." The tool shown in Fig. 1 consists of two micrometer heads mounted in a bar, which is provided with carefully reamed centers at the ends. The micrometer heads are so mounted that the ends of the spindles just coincide with the axial

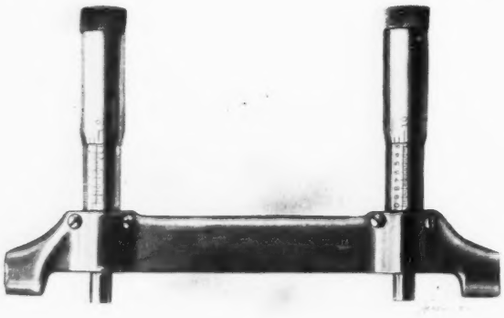


Fig. 1. Radius Micrometer for use on Centers.

line joining the centers, when the barrels register zero. The construction shown in Fig. 2 is on the same principle, the taper shank being substituted for the centered bar. This shank is offset in the part supporting the micrometer, so that the measuring point coincides with the center line when the barrel stands at zero, the same as in the double-head tool. Figs. 3, 4 and 5 show two forms of the tool in use on the lathe.

Within its range, the radius micrometer enables a turning or boring tool to be set precisely to turn or bore any required diameter. The tool also may be used to adjust the cutters held in a boring bar, and it may be used for a wide variety

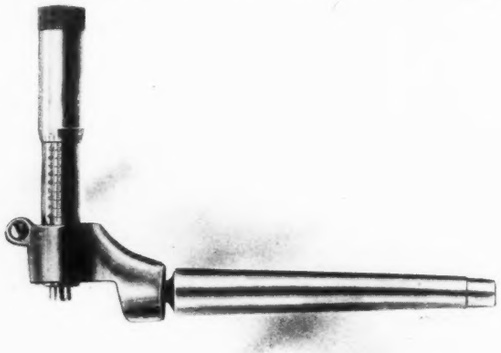


Fig. 2. Radius Micrometer, with Taper Shank.

of general work, as, for example, turning cams. The height of the cam may be measured when ordinary calipers are useless, because of the absence of metal at a point opposite the throw. The tool may also be used to measure the variation of lathes in relation to the ways, etc.

Fig. 3 illustrates the method of setting a boring tool using the form of radius micrometer shown in Fig. 2. The micrometer is mounted in the tail spindle and adjusted to read the required radius of the hole or one-half its diameter. An auxiliary attachment is required, shown at the left, this being in the form of a standard clamped to the ways and having an adjustable rod. In this view both the pointer and the micrometer are shown in a vertical position, both being turned upright so as to show clearly. The adjustable rod, shown

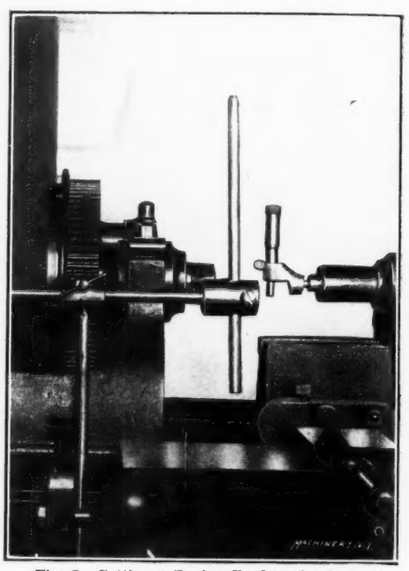


Fig 3. Setting a Boring Tool to the Correct Diameter.

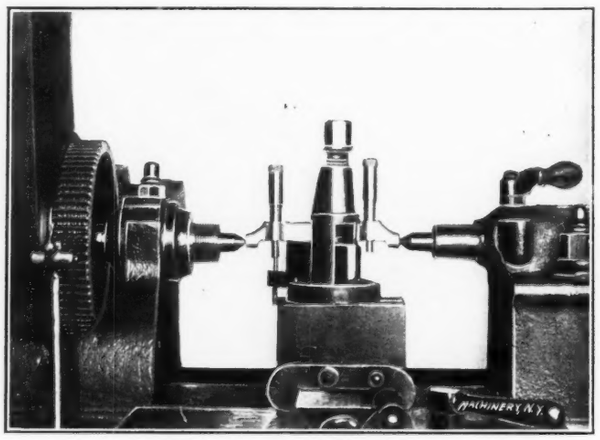


Fig. 4. Measuring the Vertical Alignment of Lathe Centers.

standing in a vertical position, is set so as to just touch the end of the micrometer spindle. After adjusting the point of the adjustable rod to touch the end of the micrometer spindle,

the tail-stock is moved back on the ways and the boring tool is put in place in the tool-post. When it is adjusted so that the cutting edge touches the end of the measuring rod, it is set to bore the radius indicated by the radius micrometer. If several cuts are required to bore the hole to size, the ordinary stop used in screw cutting may be adjusted to regulate the final cut.

Fig. 4 shows the method of using the double radius micrometer illustrated in Fig. 1 to measure the height of the lathe

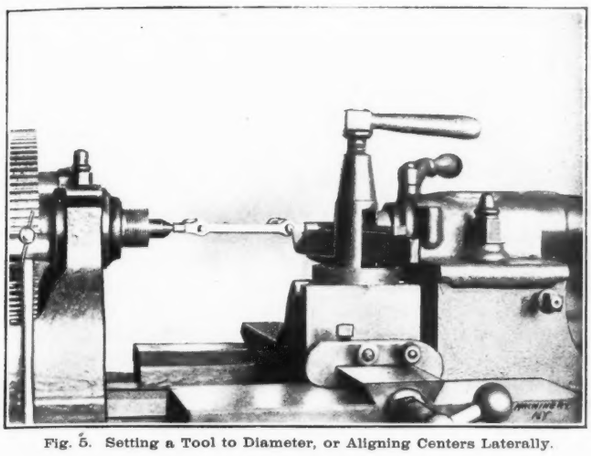


Fig. 5. Setting a Tool to Diameter, or Aligning Centers Laterally.

centers. A holder carrying a steel point is held in the tool-post, and the carriage is moved from one micrometer spindle to the other to ascertain the condition of alignment. When both micrometer barrels read the same, then the centers are in vertical alignment.

Fig. 5 shows the method of using the same instrument to set a tool to turn a desired diameter, or to secure lateral alignment of the centers. It is obvious, of course, that the tool is convenient for setting the tail-stock so as to turn tapers. Mr. Farrar states that there are many other uses of the tool which will suggest themselves to users.

COMMUTATOR TRUING DEVICE.

The Patterson Tool and Supply Co., Dayton, Ohio, is placing on the market the useful device shown herewith. It consists of a pedestal with ways formed on its top surface to carry a tool slide. The manner in which this device is used is obvious. It is blocked up beside the commutator to be trued, on the floor

Portable Tool Post for Truing Commutators.

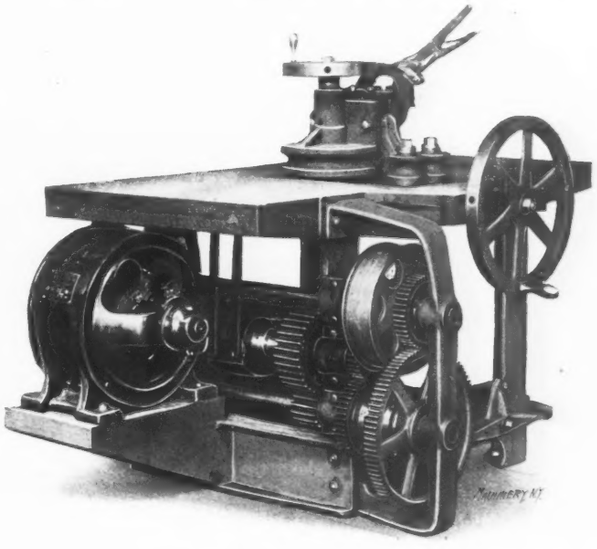
or on the base plate of the dynamo or motor, and is then clamped in position. The slide being lined up with the armature shaft, the tool is placed in the tool post, which is fed in to a depth sufficient to just finish out the inequalities of the commutator. The tool is then fed steadily by hand, by operating the longitudinal feed screw of the machine. This longitudinal feed is 15 inches in length. The cross adjustment is 5 inches, and the vertical adjustment for bringing the tool to the center line 6 inches; the tool post is for tools with shanks ⅜ x ¾ inch section. The weight of the device is about 75 pounds.

STOEVER AUTOMATIC PIPE BENDING MACHINE.

This machine, built by the Stoever Foundry and Mfg. Co., of Myerstown, Pa., is designed to bend pipe of from 1 inch to 2 inches in diameter, with a radius of bend varying between the limits of 2½ inches as a minimum for the 1-inch size, to a maximum of 12 inches.

The pipe is bent by carrying it around a circular former of the proper radius, fixed to a spindle on top of the table, as shown in the half-tone. This former or roll is made in two pieces, the joint being at the center of the groove in the roll. The lower half is fastened firmly to the spindle; the upper half is keyed to the spindle, but can be raised or lowered by means of the hand wheel shown at the top of the spindle. This dividing of the main forming roll is necessary to release the bend after it has been formed, particularly in the case of 180 degrees or "return" bends, when made cold.

The lever shown operates a vise, which can be attached to whatever former is in place on the machine at the time. This vise has jaws equipped with interchangeable steel grips or bushings, to fit various sizes of pipe. The large hand



Stoever Automatic Pipe Bending Machine.

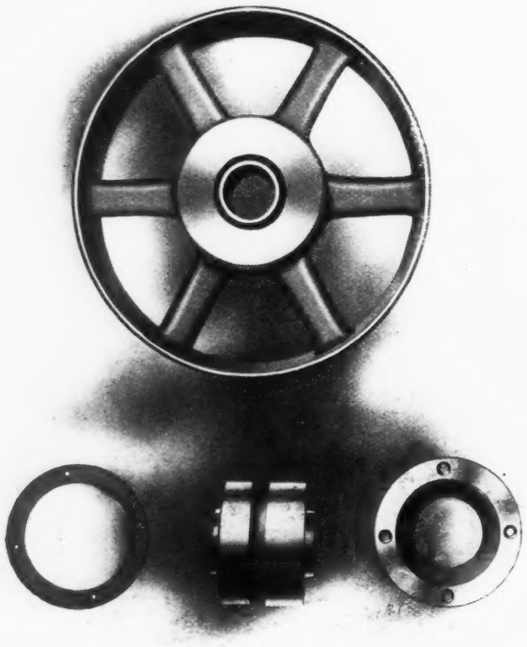
wheel shown at the front side of the table operates a slide, which may be adjusted toward or away from the central former. This slide holds two rollers, one directly in line with the main forming roll and serving to press or force the pipe onto it, while the other acts simply as a guide roller for holding the unbent portion of the pipe in the proper position. The operation of bending is, then, to introduce the pipe between the two rollers on the slide until it lies in the groove of the main former; here it is grasped at the proper point by the vise, after which the vertical spindle is started, being rotated the number of degrees required to give the bend desired.

The spindle is driven by power. The machine shown is motor driven, although the belt pulley is also in place in the foreground of the cut. The belt driven machine has but one speed. With the motor drive a variable speed motor is usually used, so that a variety of speeds can be obtained to suit the work in hand. A reversing mechanism is interposed between the motive power and the spindle, operated by a treadle within convenient reach of the operator. This serves to control the machine, and permits the spindle to be returned to the starting position rapidly, by power, after a bend has been made. Adjustable dogs are provided on the vertical spindle for stopping automatically the movement of the spindle in either direction at predetermined points, to give the degree of bend required.

In using this machine no filling of the pipe is necessary. It is placed in the machine in its normal condition, and the normal section is retained in the completed bend. Sixteen complete bends have been made in ten minutes with this apparatus. In daily runs, 300 bends have been made in 9 hours a number of times. In the work referred to, the bends were made in 2-inch pipe to a 4-inch radius, 180 degree curvature, the length of the legs being 5 or 6 feet. It will be noted from the cut and the description given, that the machine is intended for manufacturing service particularly. It is a special machine, like some forms of turret lathes and engine lathes, and when set for a single piece of work should be used on that work for some time.

JOHNSON & BASSETT SELF-OILING LOOSE PULLEY.

The subject of loose pulleys has always been a sore one. Much thought has been given to remedying the difficulties and annoyances consequent on the use of those of the common



The Johnson & Bassett Self-oiling Loose Pulley.

type. Of the various designs resulting from this extended thought, that shown in the accompanying half-tone and line cut is perhaps as promising as anything we remember to have seen. The arrangement provides for a loose pulley, having a reservoir of oil which is automatically, and yet by simple means, conducted to the bearing surface, whence it is returned

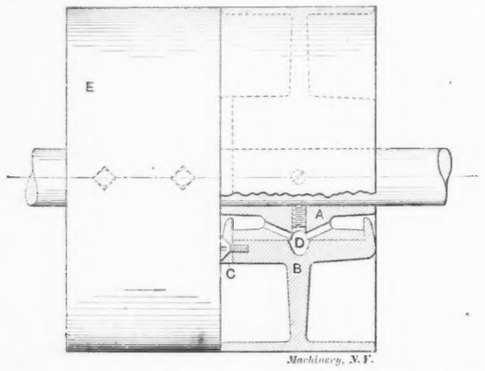


Fig. 2. Section of Pulley, showing Oil Ducts and Reservoir.

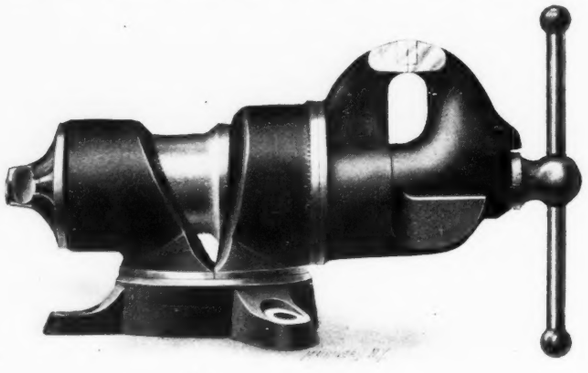
to the reservoir as fast as it escapes at the end of the bearing. The way in which this is done will be understood by referring to the cuts and the accompanying description.

The pulley does not run directly on the shaft, but on a bearing of its own secured to the shaft by set screws. This is shown at *A* in Fig. 2, and directly under the assembled pulley in Fig. 1. When the pulley *B* is slipped over this bearing, it bottoms against an internal shoulder at one end of the hub of the pulley, while endwise movement is prevented at the other end by a washer or collar *C*, which is screwed to the hub of the pulley. A channel is turned in the inner periphery of the hub and on the opposite side of the bearing, as may be seen at *D*. This furnishes the oil reservoir referred to. Deep grooves in the sides of the bearing *A* are connected with this channel by the slanting oil ducts shown. The effect of this arrangement is plainly evident with a little consideration. As the oil contained in the reservoir escapes through the bearing surface, it gradually oozes out into the side channels in the bearing, whence it is returned to the central reservoir, by centrifugal force if the shaft is running, and by gravity through whichever of the oil ducts may happen to be downward at the time, if the shaft is standing. From the reservoir, the oil repeats the cycle.

No collar is necessary to position this pulley on the shaft, since it is held by its own hub. Running as it does, on its own bearing, it can be applied to worn shafts, damaged by running with ordinary loose pulleys. The bearing is of large diameter and the surface is sufficient to hold the oil either running or standing, so that tight belts do not squeeze the oil out. The higher the speed the better the lubrication, owing to the part centrifugal force plays in distributing the oil where it is needed. The pulley is neat in appearance, and is in no sense an experimental device, having been thoroughly tested under severe conditions for the past two years. It is regularly made in various diameters of from 6 to 14 inches, with larger sizes to order. Johnson & Bassett of Worcester, Mass., are the manufacturers.

PITTSBURG VISE OF UNUSUAL SIZE.

The Pittsburg Automatic Vise and Tool Co., of Pittsburg, Pa., has built what it believes to be the largest vise ever constructed. This tool weighs 695 pounds, is 36 inches long, 18



A 695-pound Vise.

inches high, and has a jaw opening of 15 inches. It is so constructed as to secure the greatest possible strength; for instance, the jaws at the neck are over 4½ inches thick, while the slide bar is 7 inches in diameter.

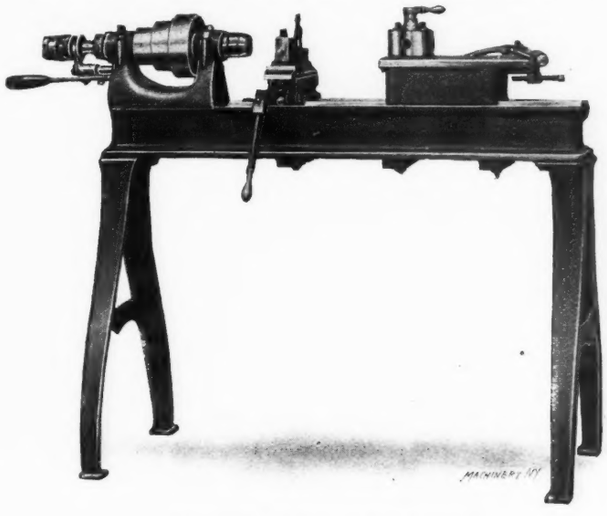
This tool is of the same design as the regular line of double swivel vises made by its builders. The whole vise may be swung in its base about a vertical axis, and the jaws may be set at any angle in the axis of the tightening screw. The setting up of the jaws on the work clamps the whole structure immovably, without requiring any special movements for this purpose. Careful fitting and smooth finish make it possible with even the large vise shown to swing the jaws around, or shift the angle of the vise itself, without requiring the workman to exert himself in the least. This tool fills the needs of shipbuilding yards, railroad and forge shops, and other works where parts of great size are handled, and for holding which provision has to be made. As an instance of the way in which it may be used, work too heavy to be lifted into a vise can be readily stood on one end on the floor and be grasped by the jaws of the chuck, which are turned at right angles for the purpose, thus getting a grip the full length of

the jaws. The heaviest work can then be performed without loosening the grip.

As a contrast to this heavy tool, mention might be made of another vise of the same design which this firm has recently added to its line. This has jaws 1¾ inch long, opening 3 inches and weighing about 3½ pounds. This is intended particularly for emergency work on motor boats and automobiles. The base in which it is set may be permanently fixed to the deck, floor, running board or seat of the machine, where its small size renders it unobjectionable. When a breakdown occurs and it is desired to use the vise, it is simply set into this base, and the tightening of the work clamps the whole structure. The parts are so designed as not to be affected by an accumulation of mud, dirt or water. By the use of extra bases, the vise can be utilized anywhere—in the work-shop, store or home. It will be seen that there is a ratio of about 200 to 1 in the weights of these two tools.

WELLS TURRET LATHE.

The F. E. Wells & Son Co., of Greenfield, Mass., are placing on the market the new lathe for manufacturing use shown in the accompanying half-tone. It is designed to meet the need for a reasonably priced tool for rapid and accurate work in the manufacture of small parts. The general design follows the lines of the other lathes built by the same makers, a noticeable point being the fact that the head-stock is cast solid with the bed. The spindle is supplied with an auto-



Turret Lathe for General Manufacturing.

matic chuck operated by a lever, so that it can be opened and closed while running at full speed. This allows small pieces to be handled rapidly. The nose of the spindle is threaded, so that geared or scroll chucks up to 8 inches in diameter can be used for handling larger pieces, such as castings, etc. When the split chucks are being used, this thread is covered by a cap. When required, a wire feed can be supplied. The turret slide is operated by a lever. The turret may have four or six holes as desired. The cut-off slide has a tool on each side of the machine, is of new and substantial design, and has tool-posts for properly carrying either straight shank tools or circular forming tools. These lathes swing 11 inches, and are made with 3, 3½, and 4-foot beds.

WELLS BROS. STANDARD AND LIMIT GAGES.

In Fig. 1 are shown standard internal and external gages for testing Briggs pipe threads on pipes, fittings, etc. They are designed particularly for reference, and are to be used by the users of pipe and fittings. Some way of testing is necessary in all material threaded with the Briggs standard, since the pipe and the fittings are seldom made by the same firms, and it is often necessary to know whether the parts supplied come to the standard size without testing them in the parts they are to go in. These gages are intended for this use. They have a uniform taper of ¾ inch to the foot to agree with the standard to which they are made. The ring gage has a thickness equal to the length of the threaded end of the pipe, and is used to test pipe ends by being screwed on as far as possible by hand, when the end of the pipe should be exactly flush with the small end of the ring. The plug gage is made three threads longer than the ring gage, with the large end the same size as the large end of the ring. When used to test pipe fittings, it is screwed in as far as possible, when the large end should come flush with the outside of the

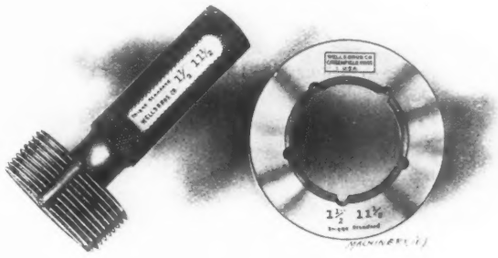


Fig. 1. Plug and Ring Gages for Testing Pipe Threads.

fitting. It will be seen that in this way the fitting is tested three threads deeper than the pipe end, so plenty of margin is allowed for forcibly screwing-in with the pipe wrench to make a tight joint. The plug and ring screw together until their large ends are flush. They are made with cuts milled through to clean out the chips from the thread being tested. Since they are tapered, it would be impossible to screw them to a bearing without this provision.

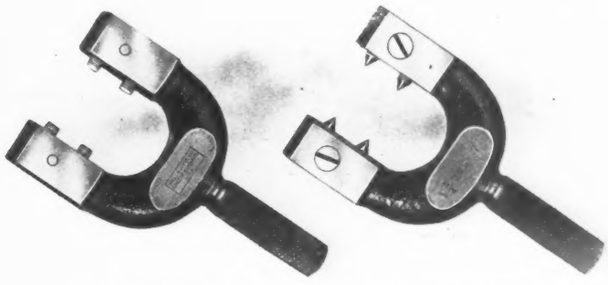


Fig. 2. Solid Limit Gages for Threaded and Cylindrical Work.

In Figs. 2 and 3 are shown limit gages for small and large work respectively. Those at the right of the cut in each case are for threaded work, while the other is for plain cylindrical work. In the thread gages the points are off-set half the pitch of the thread to allow the work to enter with the center lines square with the gage. The gage points provided are set on the common plan of having the outer pair for a "must-go-through" maximum limit, and the inner pair for a "must-

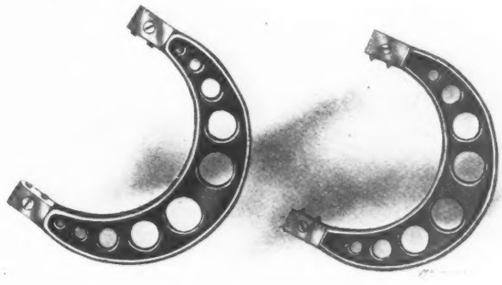


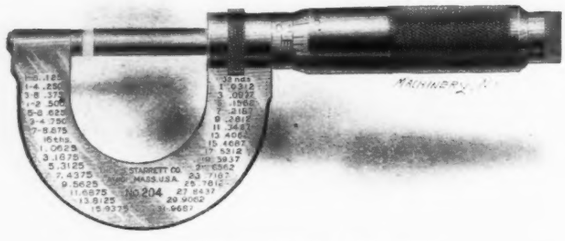
Fig. 3. Caliper Limit Gages for Large Diameters.

not-go-through" minimum limit. Ordinarily, on work of medium size, the working points are set so there is a difference of about 0.002 inch in diameter between the two limits, the first one being 0.001 inch over size, and the second 0.001 inch smaller than standard. The only difference between the limit gages for screw threads and those for cylindrical work is in the working surface, the former having points for measuring on the angle of the screw thread, while the latter has flat working surfaces. These gage points can be removed at any time, and reground if worn. They may then be read-

justed to size by comparing them with the setting disks furnished for each pair of working points; these are provided for both the threaded and the cylindrical form. These gages are made in all sizes from ¼ inch to 10 inches inclusive, the style of Fig. 2 being used up to 2½ inches in diameter, and that of Fig. 3 for larger sizes. Wells Bros. Co., Greenfield, Mass., is the maker.

THE STARRETT QUICK ADJUSTING MICROMETER.

The new micrometer shown in the cut was recently brought out by the L. S. Starrett Co., Athol, Mass. It has the interesting feature of quick adjustment. By pressing the finger on a plunger in the end of the thimble; a split nut on the micrometer screw is opened, permitting the thimble and spindle to be instantly adjusted to any required point within the capacity of the instrument; then the removal of the pressure on the plunger closes the nut and permits the exact adjustment to be made in the usual manner. Inasmuch as 40 turns

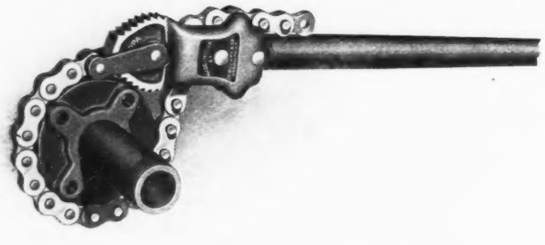


Starrett Quick Adjusting Micrometer.

of the thimble are required to move the spindle of the ordinary micrometer 1 inch, it is estimated that the quick adjustment feature saves at least 20 seconds on each extreme movement of the spindle. The micrometer has the ratchet stop, lock nut and patented sleeve by which adjustment for wear is readily made.

"AGRIPPA" PIPE AND FITTINGS WRENCH.

J. H. Williams & Co., of Brooklyn, N. Y., have made for several years the well-known Vulcan pipe wrench. They have recently placed on the market a tool operating on the same principle, for use where limited space will not permit employing the wider, or double jaw wrench. They call this a fittings wrench, since it is especially adapted for use on narrow flanges, short nipples and other parts with contracted surfaces. The tool is made throughout of wrought steel, and has a drop-forged, saw tempered jaw, permanently fastened in



The Agrippa Pipe and Fittings Wrench.

a milled seat in the handle. The chain is longer than in similar wrenches for pipe work only, and is hand made. It swings from the center of the jaw and can be used on either side. All parts are interchangeable. While this tool is only recently offered for sale, it has been thoroughly tested in some years of use. It is made in seven sizes, with a capacity for pipe and fittings from the ⅛-inch to the 12-inch size, inclusive.

DALLETT AUTOMATIC HOSE COUPLING.

This coupling is the result of a continuous series of experiments and tests, extending over a period of four years, made by the Thos. H. Dallett Co., of 23d and York streets, Philadelphia, Pa. The makers believe that the coupling resulting from these tests and experiments is as superior to that in present use as are the pneumatic tools of the present day to those of ten years ago. The cut shows the two halves of a Dallett coupling, and the gasket used between them. To connect this coupling, the parts are pressed together and given one-eighth of a turn; the locking ring springs into place of itself. It is then impossible to pull the coupling apart, or disconnect it accidentally. When the connection is to be broken, the locking ring is pressed back and the coupling

Dallett Automatic Coupling, Taken Apart.

turned back. In making the connection, the tapering end of the gasket enters the conical opening in the male part, being a loose fit therein; when the pressure comes on the coupling, this tapered end of the gasket is expanded against the wall of this opening, making a joint which increased pressure will only make the tighter. As soon, however, as the pressure is released, the gasket is again loose, so no matter how long a coupling is connected, it will not adhere when the joint is again separated. This gasket is made of a rubber composition which will not be affected by oil or gasoline. It is held in the female half by a flange around the larger end, which fits into a recess. It is thus impossible for it to fall out or be lost, though when necessary a new one can be inserted in a few seconds. As will be noted, the two members are provided with locking lugs equally spaced around the circumference, and when they are snapped together, these lugs insure their being held squarely, thus obviating the tendency to leak, as is common in other couplings of this class, especially those provided with only two lugs. This coupling is made in various sizes to fit hose and threaded ends of from ⅜ to 1¼ inch in diameter.

* * *

NEW APPLICATION OF COMPRESSED AIR.

One of the most remarkable applications of compressed air has recently been made by Mr. Phillip Brasher, Brooklyn, N. Y. He has found that the discharge of air into water below the surface breaks up the wave action of the water and leaves a practically smooth surface. In emergency cases he expects, says *Compressed Air*, that this principle may be applied to prevent the injurious action of waves on objects exposed to them. He expects that a disabled ship, drifting toward shore, by throwing out an anchor to which is fastened a distributing pipe for compressed air, and held far enough from the ship by means of a secondary anchor, could lie in perfectly smooth water until repairs were made, or the sea subsided. In the same way stranded vessels could be protected from the pounding of the waves until floated. Light ships could be surrounded by a circular pipe line and lie in the center of an absolutely calm surface. Some of the expectations, as for instance, that in the not distant future there will be harbors constructed in the middle of the ocean, in vicinities of more than ordinary roughness, by means of pipes suspended from a series of floats so placed that both floats and compressor plant will be protected from any danger of wave action, seem to be rather daring dreams of the enthusiastic inventor.

* * *

Fixing up a thing to be as good as it was before it was broken is merely setting up again the trap in which you have once been caught.

The answer to the question, "What caused it?" must be pursued with relentless energy. In the full and complete answer to this lies the way to success.

The utter absence of the need for hurry is measurably preferable to the most brilliant exhibition of it. The man who skips over an accident with the remark, "Oh, that is nothing; little things like that happen every day. We can't help it," is a dangerous man to have around.

Complaining about the stupidity of your help but proclaims your own.—*Paul Lüpke, in an address before the National Electric Light Association Convention.*

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE TOPICS.

Commercial conditions remain much the same as for some time past, but a continuance of the general pressure is not over-confidently looked forward to. Productive plants of all kinds have so greatly increased their efficiency that to keep them simply running necessitates a much larger volume of work than formerly. In labor matters, the trend indicated by the general results of strikes in the engineering trade during the last few years is unfavorable to this method of attempting to improve working conditions. This, notwithstanding an apparently successful outcome of a strike at the works of Vickers, Sons & Maxim, Ltd., Erith, against the continuance of the premium bonus system, and also directed towards the curtailment of the functions of "speed-and-feed" men. The energies of trades unions appear likely to be increasingly directed into political channels with a view to the economizing of union funds, the more effective presentation of the labor point of view in legislative discussions, and the urging forward of industrial reforms. "Collective" bargaining respecting disputes or changes in trade customs is being almost forced into general recognition, the unwisdom of avoidable stoppages in large industries being more clearly seen than formerly.

Shipbuilding Records.

Though the shipbuilding returns of the first half of the present year do not compare so favorably as was anticipated with the same period of last year, individual concerns have made some remarkable records. John Brown & Co., Ltd., of Sheffield and Clydebank, recently launched the armored cruiser *Inflexible*, the completed cost of which will be about $8,650,000, and also delivered the Cunard liner *Lusitania* for her preliminary trials. The concern also has other large orders on its books. It has practically completed the purchase of a valuable ironstone field at Frodingham, and has also strengthened its shipbuilding connection by the acquisition of an interest in the firm of Harland & Wolff, Ltd., Belfast, which will necessitate the creation of about $7,500,000 additional capital. The latter firm is to build nine steamers for the Morgan combine at a cost of about $20,000,000. About $250,000 are being expended on immediate extensions. The combined firms will employ about 30,000 men, and will be able to turn out battleships complete with guns, mountings, and armor plate, in addition, of course, to the most modern types of commercial vessels. Harland & Wolff are also building large repair shops at Southampton.

Legislation Against Trusts.

Efforts are being made to legally restrict the monopolistic conditions laid down by certain machinery trusts, of which the shoe machine trust is typical. Clauses are being introduced into the new patent laws by which conditions of sale or lease which call for the user of a patented machine to use other articles or inventions, or to prohibit him from using any other than those dictated by the patentee, will be void. It is also intended to empower the Board of Trade to appoint an arbitrator in connection with the termination of existing contracts of the kind, to assess the compensation to be paid for the determination of the agreements in question. The Australian Commonwealth government also propose to put in force the extreme powers of their customs regulations in case more equitable terms are not speedily granted.

"Stringer-type" Composing Machine.

An interesting machine is being brought to the notice of the printing trade over here, in the shape of the "Stringer-type" matrix composing and casting machine. The machine is named after the inventor, Mr. H. J. S. Gilbert-Stringer, and its special feature is the ability to produce movable type ready for machinery purposes at the rate of 9,000 to 10,000 per hour by one operator. Certain of the linotype features are embodied as regards the keyboard and the arrangement of matrices, together with advantages associated with machines of the perforated ribbon or monotype variety. The characters are on the flat face of the matrices and not on the edge, hair lines practically being eliminated. The temperature of the metal is automatically adjusted, and the variation of the spacing between the words is similarly attended to. Safety stops are provided in the case of a matrix being incorrectly placed on its way from the magazine, or if too much is endeavored to be set in one line. The bottom end of each type has the fin caused by casting so automatically knocked off that the bearing surfaces left allow the length of the type to be kept within extremely fine limits. The frame of the mold is cooled by water circulation so that the type may easily be handled when cast at the highest speeds. Quite a number of other points appealing to the printer are claimed, but, apart from the good quality of work apparently obtained from it, the point most likely to attract favorable attention is the fact of one man performing the whole of the operations.

Trade Conditions and the Tariff.

Little has been heard of late in the way of holding up the principal industrial nations as models or warnings to the others. It is increasingly evident that much is to be learned from the practice evolved by force of circumstances in each country, and that a deficiency in one respect is often fully counterbalanced by special efficiency in another direction. What lecturing is taking place would appear mainly devoted to pointing out to American manufacturers directions in which their typical mass production methods fail to compete favorably with the productions of countries less favorably placed as regards supplies of raw materials, but in which latter countries artistic bent or technical skill adds considerably to the value of the finished product. Great Britain received a considerable amount of well-meant advice until fairly recently, the United States being prominently placed as the exemplar, but most of the admonitory statements now current are concerned with the presentation of the theory that unless a move is made in the direction of protective tariffs, Continental competitors, owing to their home market being largely preserved for them, have inducements to carry out an aggressive foreign trade policy, whereas the British manufacturer, through his Free Trade environment, is practically precluded from such a stimulus. It may be more or less so, such statements are hard to prove or disprove.

Dr. Nicolson on Rational Machine Design.

Dr. Nicolson of the Manchester School of Technology has for some years been working with a view to the designing of machine tools being conducted on "rational" lines as distinct from the more generally followed plan of advancing tentatively from designs which, notwithstanding certain deficiencies, gave good service under working conditions. Some deductions from experiments made by him, and mentioned in a paper recently discussed by the Institute of Civil Engineers, appear to suggest that lathes should be capable of taking a cut equal to one-fortieth the height of centers, with a feed one-fourth of this. The ratio between the highest and lowest speeds on lathes designed to use carbon steel tools is indicated as 50 to 1 on 12-inch swing lathes, to 180 to 1 on 120-inch swing lathes. When employing high-speed steels the ratios are 10 to 1 on 12-inch swing lathes, to 120 to 1 on 120-inch swing lathes. He considers that the power available in high-speed lathes should be from three to seven times that required for lathes using tools of carbon steel. Dr. Nicolson also advocates front bearings of smaller diameter than often used on British high-speed lathes, a view dissented from by a number of makers, who draw attention to the weight of face-plates and heavy jobs often suspended from them. Another suggested innovation is the use of solid bush bearings without means of adjustment, but with arrangements for forced lubrication, to prevent metal and metal contact at the lower speeds, the spindles, as before mentioned, being of smaller diameter than now usual, and the front bearings only about half the present length. The form of bed strongly recommended for adoption is of circular or box form in place of the double H section with cross girts, commonly employed. Many practical objections may be urged against such a departure, but the author of the paper considers that such difficulties may be satisfactorily overcome, when toolmakers are

disposed to give such a form of bed a thorough trial, its bending and torsion resisting qualities being such as to justify reasonable expenditure in its development. In any case, Dr. Nicolson's ventilation on the subject is likely to lead to its more consistent treatment by designers and builders.

Commercial and Technical Education.

Commercial and industrial or technical education obtains fairly constant attention even though it be of a critical rather than constructional character. The Birmingham University authorities are forming an advisory board of engineering business men to assist in the inauguration of a scheme of training in the commercial side of engineering. At Oxford University it is proposed to found a chair of engineering. No attempt at practical training is proposed at present. In Lancashire some difficulty exists as regards placing students in positions after attending technical schools. Manufacturers have not yet become accustomed to the idea of frankly assimilating in their works organization technical school graduates, and consequently disappointment is expressed both by students and those responsible for the general oversight and administration of educational matters in the county. In a recent report of the Lancashire County Education Committee it was stated that the work sent in by students in the textile branches—who submit samples of work designed and actually woven by them—was considerably superior to all previous efforts, there being an entire absence of unworthy material. The weakest feature of the work was the coloring, which was crude in several instances. On the results of these competitions scholarships tenable for three years at the Manchester School of Technology are awarded, and also various prizes. Every effort is being made to train students to be of service to employers, but as previously mentioned, a mutual understanding is not as yet arrived at as to what is required from students after completing their courses.

JAMES VOSE.

Manchester, Eng., August 1, 1907.

MISCELLANEOUS FOREIGN NOTES.

GERMAN SHIP BUILDING INDUSTRY.—Like all other industries, the ship-building yards in Germany increased their business materially during 1906. The tonnage of new merchant vessels constructed was 387,820 tons, as compared with 277,731 tons in 1905. This represents an increase of 32.4 per cent. At the close of 1906 there were under construction in various German ship-building yards merchant vessels with an aggregate tonnage of 323,000 tons.

RŒCHLING IRON AND STEEL WORKS, Voelklingen, Germany, has put into operation a new Kjellin induction steel furnace, having a capacity of 24 tons. About 15 tons are poured at the end of each run, 9 tons being left for the beginning of the next run. The power consumption is 736 kilowatts per hour. There are two smaller induction furnaces in operation at these works and a fourth in construction, having a capacity of 150 tons. A high production economy is claimed for the new plant.

BRITISH AUTOMOBILE INDUSTRY.—According to the London *Times* the motor car industry in Great Britain is still in a state of remarkable progress. The business of 1906 doubled that of 1905, while in 1907 every indication points to a demand far exceeding anything yet experienced. The home product has succeeded in competing with the foreign vehicle. Not so long ago it was almost impossible to find a British car outside the boundaries of the United Kingdom, except those owned by British tourists. Now there is a distinct and growing demand for them in the British colonies, in America, and on the Continent. The exports for the first four months this year amounted to $1,243,525 in finished cars, and $796,940 in automobile parts. This is more than double the exports for the same period in 1906.

INDUSTRIAL CONDITIONS IN SWEDEN.—The industrial development of Sweden depends largely upon the development of the country's resources of power, obtainable from the waterfalls, and convertible into electrical energy. The value of these resources is becoming more appreciated than ever, and electrical machine companies are prospering. The largest of these is reported to have delivered, in 1906, 3,319 electrical machines, with a total of 87,720 H.P., and to have orders on hand for machines of more than 200,000 H.P. The machine-tool industry is in a flourishing state, but the production of the country in this line falls by far short of the demand, and high class American machinery finds a ready sale at the present time.

STANDARDIZATION OF MOTOR PARTS IN GREAT BRITAIN.—It is reported that the British Institute of Automobile Engineers has appointed a committee for inquiring into the possibility of a standardization of motor parts. It is appreciated that those accessories and component parts used in engines of all types, as well as nuts, bolts, bolt heads, and wrenches, could be made the same on all kinds of modern automobiles, not only in the United Kingdom, but on the Continent as well. One difficulty in the standardization is the fact that Continental motor makers use the metric system, while manufacturers in Great Britain do not. The fact that this subject is receiving attention is an important one as the first step toward agreements which are likely to be beneficial to the motor manufacturers in all countries.

THE PROPOSED WORLD'S FAIR IN BERLIN.—Some time ago it was announced in the press that an initiative had been taken in leading industrial and political circles for the arranging for a world's fair in Berlin, Germany, 1913. The immediate cause for the selection of this year was the twenty-fifth year anniversary of the German Emperor's ascension to the throne of the empire. On account of this proposition the German Commercial Union sent out a circular letter to the German chambers of commerce in order to learn their views with reference to a world's exposition, to be held at Berlin in 1913 or other year of the coming decade. In answer to this the chamber of commerce at Mayence has recently adopted the following resolution, which seems to voice the opinion generally entertained in Germany concerning world's fairs: "The chamber of commerce has resolved to answer that it can not recognize the holding of a world's exposition at Berlin in the year 1913, or in some other year of the coming decade, as in the interest of Germany's industries and commerce; that it deems it more advisable, instead of general world's expositions, to organize for all products of human activity international expositions of a special industry, as such only can have the effect of fructifying and stimulating the industries and trades."

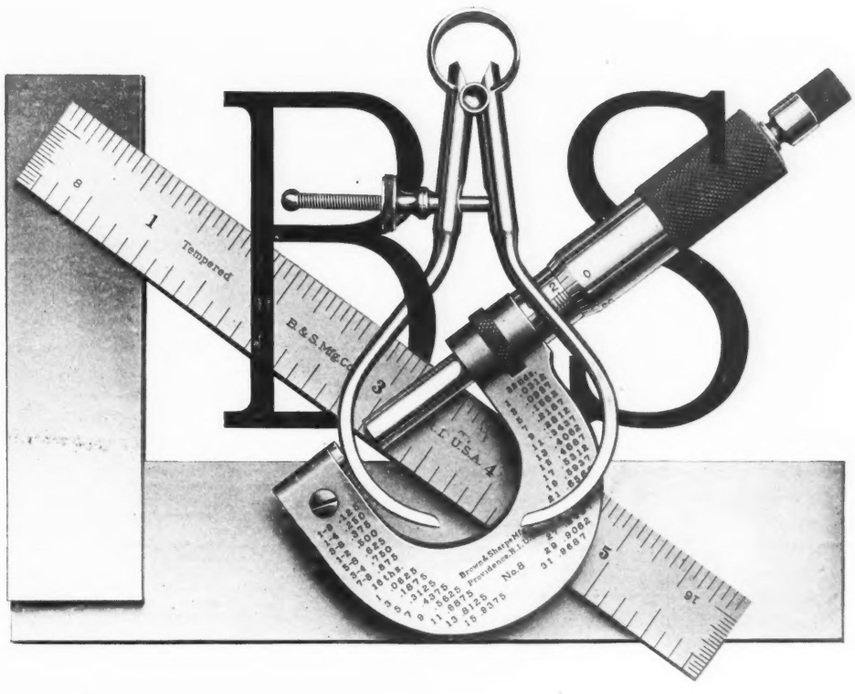
* * *

THE KRONPRINZESSIN CECILIE.

The latest addition to the passenger fleet of the North German Lloyd Steamship Company, the *Kronprinzessin Cecilie*, arrived in New York harbor August 14, 1907. This boat is another evidence of the faith in the commercial possibilities of the large size, high speed, luxuriously equipped vessel. The use of reciprocating engines has been continued, this being in line with German engineering practice, which is inclined to regard the steam turbine as not yet out of the experimental stage. The vessel is propelled by twin-screws, each driven by two quadruple expansion engines. The cylinder diameters are as follows: High pressure, 37⅜ inches in diameter; first intermediates 49¼ inches; second intermediates, 74⅞ inches; and low pressure, 112¼ inches; the common stroke is 6 feet. The horse-power is 45,000. The comparison of this figure with the 70,000 horse-power of the *Lusitania* gives some idea of the cost of raising the speed of two vessels of comparable size from 24 knots per hour to the 25½ knots which the new English vessel is expected to make. The most impressive thing to the visitor on the *Kronprinzessin Cecilie*, aside from the great size of the vessel, is the perfection of detail which has been observed throughout the boat in the matter of fittings, furnishings and decoration. There is something very fine in the design and workmanship of even the most inconspicuous details of the interior decoration, and this rises to a high pitch of beauty in the case of the dining room and saloons, and the more luxurious of the staterooms and suites.

BROWN & SHARPE MFG. COMPANY

PROVIDENCE, R. I., U. S. A.



QUALITY

THE INHERENT CHARACTERISTIC OF

B. & S. TOOLS

BRINGS OUT THEIR MOST PROMINENT FEATURE,

DURABLE EFFICIENCY

OBITUARY.

Henry W. Clarke, senior member of Hill, Clarke & Co., Boston, Mass., died July 27 at his home in Watertown, near Boston. Mr. Clarke was born May 10, 1822. He began his business career in hardware, being first employed by George H. Gray & Danforth, of Boston. In 1866 he became connected with the firm of Horace McMurtrie & Co., who were engaged in engineering enterprises and in selling machinery. The firm was later reorganized as Hill, Clarke & Co. Mr. Clarke was actively connected with the company until about two years ago. His son, Charles A. Clarke, is the present president of the company.

* * *

PERSONAL.

T. B. Burnite of the engineering and sales department of The John A. Traylor Machinery Company, Denver, Colo., has been appointed superintendent.

E. B. Boye, until recently manager of the Cleveland office of Messrs. Manning, Maxwell & Moore, has accepted a position with the Warner & Swasey Co., Cleveland, O., as its Chicago representative.

J. Cecil Nuckols, for the past three years advertising manager of The S. Obermayer Co., Cincinnati, O., has recently received the additional appointment of advertising manager of the Cincinnati Electrical Tool Co.

George H. Hall, who for the past four years was connected with the sales department of the Crocker-Wheeler Co., Ampere, N. J., has accepted the position of manager of the Boston office of the Diehl Mfg. Co., Elizabethport, N. J. Mr. Hall was formerly associate editor of MACHINERY.

F. B. Maltby, who has been connected with the Panama Canal work as principal assistant engineer to Mr. J. F. Stevens, has resigned to go with Dodge & Day, Philadelphia, Pa., in the capacity of chief engineer. Mr. Maltby is a graduate of the University of Illinois, class of 1882, and has had a wide engineering experience.

* * *

NEW BOOKS AND PAMPHLETS.

A COURSE IN STRUCTURAL DRAFTING. 64 pages, 6 x 9 inches, with 48 cuts, numerous tables and diagrams, and 15 large folding plates. Published by the Industrial Magazine, Collinwood, Ohio.

This book is, so far as we know, the first one treating the subject of structural drafting from the drafting room standpoint. It deals with the conventions used in making drawings, discusses the technique of the business, and gives a very lucid introduction to the subject of structural design. The scope of the work can be gathered from the following chapter headings: General Remarks, Terms Used, etc.; Riveting, Spacing; Bolts, Pins and Eyebars; Connection Angles and Anchors; Copying; Strength of Materials; Beams, Girders; Column and Sole Plates; Truss Outlines; Title Page and Cover; Drafting Room Practice. It is a pity that a book as excellent as this appears to be should not have had more careful proofreading. Errors are noticeable on almost every page. We trust that its popularity will be sufficient to require a new edition in the near future, at which time these defects can be remedied.

CATALOGUES AND CIRCULARS.

THE CUSHMAN CHUCK CO., Hartford, Conn. 1907 catalogue and price list of chucks and face-plate jaws, describing the different types and discussing repair parts, outfits for lathes, etc.

THE ELECTRIC CONTROLLER & SUPPLY CO., Cleveland, O. Illustrated bulletin descriptive of universal insulator supports, touching upon application, construction, special work, cost, advantages, etc.

THE PITTSBURG AUTOMATIC VISE AND TOOL CO., Pittsburg, Pa., has issued a unique catalogue, in black and white, illustrating its special automobile and motor boat vise.

GOODELL-PRATT CO., Greenfield, Mass. Catalogue No. 8 for toolsmiths, illustrating and describing automatic drills, punches, hack saws, vises, etc. The company has added more than fifty new tools to its line since issuing its last catalogue.

LUCAS MACHINE TOOL CO., Cleveland, O. Pamphlet entitled "Pull," which states that the best way to get a "pull" is to push, and describes the four ways in which this company pushes its machines.

THE O. K. TOOL HOLDER CO., Shelton, Conn. Catalogue illustrating the lathe, shaper and planer tools, and drop forgings manufactured by this company. The various combinations of these tools and toolholders, their sizes and prices are included.

THE BURKE MACHINERY CO., Cleveland, O. Catalogue on machine tools, describing the various types of milling machines and attachments, drill presses, vises, tapping machines, etc., manufactured by this company. A price list is also issued with this catalogue.

J. T. SLOCOMB CO., Providence, R. I. Catalogue No. 11 illustrating and giving brief descriptions, with prices, of micrometer calipers and gages. The book also includes tables of decimal equivalents, drill list, and instructions how to read a micrometer.

INDEPENDENT PNEUMATIC TOOL CO., First National Bank Building, Chicago, Ill. Catalogue No. 8 illustrating and describing the complete line of Thor pneumatic tools and appliances. A number of interesting photographs show these tools at work under different conditions.

J. M. CARPENTER TAP AND DIE CO., Pawtucket, R. I., has compiled in convenient form the recently adopted standard of the American Society of Mechanical Engineers for machine screws and machine screw taps and dies. A copy will be sent to all users of machine screws, who apply.

J. L. OSGOOD, Buffalo, N. Y. Card illustrating and describing the Osgood "indestructible" file and tool handles. These are made with a thin steel tube forced into the handle and interlocked with the ferrule. The construction is such that the file tang is held in a wood seating the same as in usual construction, but the tube restrains the handle from splitting.

WESTINGHOUSE MACHINE CO., Pittsburg, Pa. Catalogue descriptive of the Westinghouse storage battery for stationary use. The company has spent many years in studying the various types of storage batteries, and has made many exhaustive tests, the result of its work being embodied in the type S storage battery here completely described and illustrated.

THE PITTSBURG AUTOMATIC TOOL & VISE CO., Pittsburg, Pa., has published a book in two colors describing and illustrating the Pittsburg two-way vise. It deals particularly with "high-speed" bench vises. The cover of the book is an attractive design in color showing a Pittsburg mill scene. Copies may be obtained by applying to any of the agents of the company or to the general office at Pittsburg.

THE L. S. STARRETT CO., Athol, Mass. Catalogue No. 18 containing 232 pages description of fine mechanical tools and illustrated with over 300 engravings. Many new and unique tools are shown and some additions to the sizes of former tools have been made. A number of improvements in design have been incorporated in certain tools and a few changes in prices. The new catalogue has been carefully revised and every tool is indexed both by name and number.

CHICAGO PNEUMATIC TOOL CO., Fisher Building, Chicago, Ill. Catalogues No. 23 and 24. Catalogue No. 23 contains more than 100 pages and is devoted exclusively to Franklin air compressors, containing descriptive matter and information. Catalogue No. 24 also contains more than 100 pages and is devoted to the company's line of pneumatic tools and appliances, including "Boyer" and "Keller" hammers, "Little Giant" drills, sand rammers and hoists.

GOLDSCHMIDT THERMIT CO., 90 West St., New York City, has recently issued pamphlets entitled "Butt-Welding Wrought Iron and Steel Pipes and Rods by the Thermit Process" and "Metals Free from Carbon Produced by Aluminothermic Method." The former contains a description of the process of butt-welding and equipment to be used. The latter is a reprint from *Electrochemical Industry* and *Electrochemical and Metallurgical Industry*.

AMERICAN LOCOMOTIVE CO., 111 Broadway, New York, has just issued the ninth of its series of pamphlets covering the standard types of locomotives. As the title indicates, this number of the series is devoted to six-wheel switching locomotives, and contains half-tone illustrations and the principal dimensions of twenty-six different designs of this type. The designs illustrated range in weights from 102,000 to 176,500 pounds, and are adapted to a variety of service conditions.

THE NEWALL ENGINEERING CO., LTD., Warrington, England. Catalogue of gages and measuring machines. This pamphlet, which contains about 70 pages, describes and lists one of the most complete and interesting line of gages that has ever come to our notice. The completeness of the line may be judged from the following list, giving some of the tools manufactured: Internal limit gages; fixed point external limit gages; adjustable external limit gages; double end external limit gages; limit reference bars; standard reference bars; internal micrometers; external micrometers; standard cylindrical gages; standard end measuring rods; standard snap gages; length micrometers; length gages; end measuring blocks; spherical end measuring blocks; standard screw gages; pipe thread screw gages; hardened screw gages; taper gages; surface plates; straight edges; and measuring machines. These are made in both English and metric sizes.

MANUFACTURERS' NOTES.

THE SCHWERDTLE STAMP CO., Bridgeport, Conn., in order to accommodate its growing business, is building a three-story addition to its plant, which will be ready for occupancy about October 1.

NORTHERN ENGINEERING WORKS, 26 Chene St., Detroit, Mich., has installed power station cranes, one of 20 tons capacity, for the Toledo Gas and Electric Co., and two of 20 tons capacity in the Murphy power plant at Detroit, Mich.

THE DAYTON PNEUMATIC TOOL CO., Dayton, O., owing to its increased business in the Buffalo district, has established an agency with Root, Neal & Co., 178-180 Main St., Buffalo. This concern will carry in stock a complete line of Dayton and Green pneumatic hammers, as well as repair parts and accessories.

THE PITTSBURG AUTOMATIC VISE AND TOOL CO., Pittsburg, Pa., has recently replaced the entire vise equipment of several of the larger plants of the U. S. Steel Corporation with the high speed Pittsburg vise. The company reports a very large volume of business from their exhibit at the Jamestown Exposition.

THE S. OBERMAYER CO., Cincinnati, O., has just completed a factory for the exclusive manufacture of Kantbebeat dry core compound. This factory has a capacity of 25 tons per day, and the company expects, from present indications, that the sales of this commodity will increase to a great extent.

THE CARNEGIE LIBRARY (Technology Department), Pittsburg, Pa., is making an extensive collection of trade catalogues, and will be glad to receive catalogues from MACHINERY's advertisers. These catalogues will be given a prominent place on the shelves, carefully indexed under both firm name and subject, and made accessible to the public. Catalogues should be addressed care of H. W. Craver, Technology Department, Carnegie Library, Pittsburg, Pa.

AMERICAN LOCOMOTIVE CO., 111 Broadway, New York City, has recently received an order for 101 four-wheel motor trucks for the Brooklyn Rapid Transit Co. The trucks will be built entirely to designs prepared by the builder, following closely the M. C. B. standards, and will embody as far as possible the practices of locomotive construction, thereby insuring strength combined with easy riding qualities, the two essential characteristics of the motor truck of the present day.

THE HOGGSON & PETTIS MFG. CO., New Haven, Conn., reports that a fire broke out in its japanning room on August 6. The damage, however, was confined to this department and interfered in no way with the manufacture of the Sweetland chuck. Although very busy in the chuck department, the company, having lately considerably increased its capacity, is able to make prompt deliveries. Important improvements are being made, which will appear from time to time.

ARMSTRONG BROS. TOOL CO., 113 N. Francisco Ave., Chicago, Ill., owing to the rapid increase of its business, has been compelled to make further additions to the large modern plant which it erected about two years ago. These consist of two buildings of steel and brick construction, one 50 ft. x 105 ft., the other 40 ft. x 105 ft., with brick smoke stack, 60 inches diameter, 115 feet high. In these buildings the company is now installing a modern power plant of 300 H. P., consisting of two 150 H. P. water tube boilers equipped with automatic stokers, direct-connected engine and generator, etc., and an up-to-date drop forge department of large capacity with steam drop hammers of the latest improved design and other high grade equipment, including a complete die shop with machine tools, especially adapted to that important work. The machinery is now being set in position and will be in operation about October 1.

MACHINERY'S DATA SHEETS
Contributions and data suitable for publication in these Data Sheets are solicited.
MACHINERY, September, 1907.
Data Sheet No. 73.
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PUNCH O

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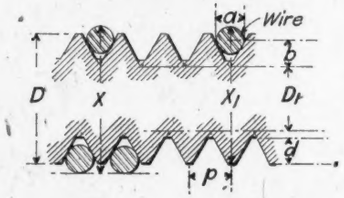
MEASURING SCREW THREADS.—II.

U.S STANDARD



n = number of threads per inch

p = pitch = $\frac{1}{\text{no. of threads per inch}}$

d = depth of thread = $0.6495p = \frac{0.6495}{n}$

D = diameter on top of threads

$D_1 = D - \frac{1.5155}{n}$

a = diameter of wire { maximum diam. = $1.010p$; minimum diam. = $0.505p$

$b = a$

$x = D_1 + 2b + a = D_1 + 3a$

$x_1 = \frac{D}{2} + \frac{D_1}{2} + b + \frac{a}{2} = \frac{D + D_1 + 3a}{2}$

D	n	d	D_1	a and b	x	x_1
1/4"	20"	.0325"	.1742"	0.040"	.2942"	.2721"
5/16	18	.0361	.2283	"	.3483	.3304
3/8	16	.0406	.2803	"	.4003	.3876
7/16	14	.0464	.3292	"	.4492	.4433
1/2	13	.0500	.3834	0.060	.5634	.5317
9/16	12	.0541	.4362	"	.6162	.5893
5/8	11	.0590	.4872	"	.6672	.6460
11/16	11	.0590	.5497	"	.7297	.7086
3/4	10	.0649	.5984	"	.7784	.7643
13/16	10	.0649	.6610	"	.8410	.8267
7/8	9	.0722	.7066	0.100	1.0066	.9408
15/16	9	.0722	.7691	"	1.0690	1.0033
1	8	.0812	.8105	"	1.1105	1.0553
1 1/8	7	.0928	.9085	"	1.2085	1.1667
1 1/4	7	.0928	1.0335	"	1.3335	1.2917
1 3/8	6	.1082	1.1224	"	1.4224	1.3987
1 1/2	6	.1082	1.2474	"	1.5474	1.5237
1 5/8	5 1/2	.1180	1.3494	0.150	1.7994	1.7122
1 3/4	5	.1299	1.4470	"	1.8970	1.8234
1 7/8	5	.1299	1.5720	"	2.0220	1.9484
2	4 1/2	.1443	1.6632	"	2.1132	2.0566
2 1/8	4 1/2	.1443	1.7882	"	2.2382	2.1816
2 1/4	4 1/2	.1443	1.9132	"	2.3632	2.3066
2 3/8	4	.1624	1.9960	"	2.4460	2.4105
2 1/2	4	.1624	2.1210	"	2.5710	2.5355
2 3/4	4	.1624	2.3710	"	2.8210	2.7855
3	3 1/2	.1856	2.5670	0.200	3.1670	3.0835
3 1/4	3 1/2	.1856	2.8170	"	3.4170	3.3335
3 1/2	3 1/4	.2000	3.0337	"	3.6337	3.5668
3 3/4	3	.2165	3.2448	"	3.8448	3.7974
4	3	.2165	3.4948	"	4.0948	4.0474

Contributed by Walter Cantelo.

No. 73, Data Sheet, MACHINERY, September, 1907.

PUNCH O

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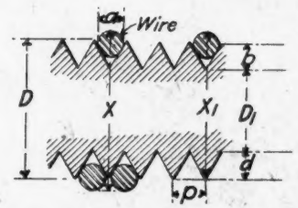
MEASURING SCREW THREADS.—I.

60° V THREAD



n = number of threads per inch

p = pitch = $\frac{1}{\text{no. of threads per inch}}$

d = depth of thread = $0.866p = \frac{0.866}{n}$

D = diameter of top of threads

D_1 = root diameter = $D - 2d$

a = diameter of wire { maximum diam. = $1.155p$; minimum diam. = $0.577p$

$b = a$

$x = D_1 + 2b + a = D_1 + 3a$

$x_1 = \frac{D}{2} + \frac{D_1}{2} + b + \frac{a}{2} = \frac{D + D_1 + 3a}{2}$

D	n	d	D_1	a and b	x	x_1
1/4"	20"	.0433"	.1634"	0.040"	.2834"	.2667"
5/16	18	.0481	.2163	"	.3363	.3244
3/8	16	.0541	.2667	"	.3867	.3808
7/16	14	.0617	.3138	0.060	.4938	.4656
1/2	12	.0722	.3557	"	.5357	.5178
9/16	12	.0722	.4182	"	.5982	.5803
5/8	11	.0787	.4676	"	.6476	.6363
11/16	11	.0787	.5300	"	.7100	.6987
3/4	10	.0866	.5768	0.100	.8768	.8134
13/16	10	.0866	.6393	"	.9393	.8759
7/8	9	.0962	.6826	"	.9826	.9288
15/16	9	.0962	.7450	"	1.0450	.9912
1	8	.1082	.7835	"	1.0835	1.0417
1 1/8	7	.1237	.8776	"	1.1776	1.1513
1 1/4	7	.1237	1.0026	"	1.3026	1.2763
1 3/8	6	.1443	1.0863	0.150	1.5363	1.4556
1 1/2	6	.1443	1.2113	"	1.6613	1.5806
1 5/8	5	.1732	1.2786	"	1.7286	1.6768
1 3/4	5	.1732	1.4036	"	1.8536	1.8018
1 7/8	4 1/2	.1924	1.4900	"	1.9400	1.9075
2	4 1/2	.1924	1.6150	"	2.0650	2.0325
2 1/8	4 1/2	.1924	1.7400	"	2.1900	2.1575
2 1/4	4 1/2	.1924	1.8650	"	2.3150	2.2825
2 3/8	4 1/2	.1924	1.9900	"	2.4400	2.4075
2 1/2	4	.2165	2.0670	0.200	2.6670	2.5835
2 3/4	4	.2165	2.3170	"	2.9170	2.8335
3	3 1/2	.2474	2.5050	"	3.1050	3.0525
3 1/4	3 1/2	.2474	2.7550	"	3.3550	3.3025
3 1/2	3 1/4	.2664	2.9670	"	3.5670	3.5335
3 3/4	3	.2886	3.1727	"	3.7727	3.7613
4	3	.2886	3.4227	"	4.0227	4.0113

Contributed by Walter Cantelo.

No. 73, Data Sheet, MACHINERY, September, 1907.

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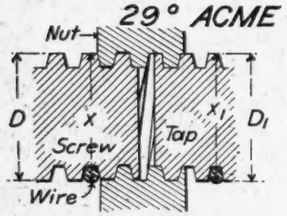
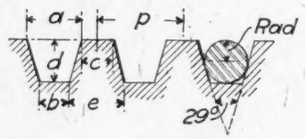
MEASURING SCREW THREADS.—IV.

29° ACME SCREW THREAD





SCREW THREAD

p = pitch = $\frac{1}{\text{no. of threads per inch}}$
d = depth of thread = $\frac{p}{2}$ + 0.010"
a = space at top = 0.6293 p
b = space at bottom = 0.3707 p − 0.0052"
c = thickness at top = 0.3707 p
e = thickness at bottom = 0.6293 p + 0.0052"
D = diameter at top of thread
x = D + 0.010"

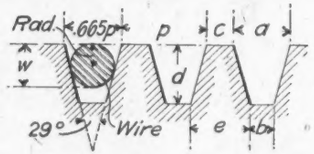
TAP THREAD

p = pitch = $\frac{1}{\text{no. of threads per inch}}$
d = depth of thread = $\frac{p}{2}$ + 0.020"
a = space at top = 0.6293 p + 0.0052"
b = space at bottom = 0.3707 p − 0.0052"
c = thickness at top = 0.3707 p − 0.0052"
e = thickness at bottom = 0.6293 p + 0.0052"
D_1 = diameter at top of thread = D + 0.020"
x_1 = D_1 − D + 0.020"

Threads per inch	p	d	Diameter of wire	Threads per inch	p	d	Diameter of wire
½	2.000"	1.0100"	0.9785"	3	0.3333"	0.1767"	0.1664"
¾	1.500	0.7600	0.7349	4	0.2500	0.1350	0.1278
1	1.000	0.5100	0.4913	5	0.2000	0.1100	0.1014
1⅓	0.750	0.3850	0.3694	6	0.1667	0.0933	0.0852
1½	0.667	0.3433	0.3288	7	0.1429	0.0814	0.0736
1¾	0.571	0.2957	0.2824	8	0.1250	0.0725	0.0649
2	0.500	0.2600	0.2476	9	0.1111	0.0655	0.0581
2½	0.400	0.2100	0.1989	10	0.1000	0.0600	0.0527

The wire used is of such diameter, that when laid in the thread groove of the tap, it will be flush with the top of the threads, and when laid in the thread groove of the screw, it will extend beyond the top of the threads 0.010".

THE BROWN AND SHARPE 29° WORM THREAD



p = pitch = $\frac{1}{\text{no. of threads per inch}}$
d = depth of thread = 0.6866 p
a = space at top = 0.665 p
b = space at bottom = 0.310 p
c = thickness at top = 0.335 p
e = thickness at bottom = 0.690 p
w = diam. of wire = 0.5149 p

Pitch	d	Wire Diam.	Pitch	d	Wire Diam.
2.000	1.3732	1.0298	.3333	.2288	.1716"
1.750	1.2015	.9010	.2500	.1716	.1287
1.500	1.0299	.7723	.2000	.1373	.1030
1.250	.8582	.6436	.1667	.1144	.0858
1.000	.6866	.5149	.1250	.0858	.0643
.750	.5150	.3862	.1111	.0763	.0582
.500	.3433	.2574	.1000	.0687	.0515

The wire used is of such diameter that it will be flush with the top of the thread when laid in the thread groove.

Contributed by Walter Cantelo.

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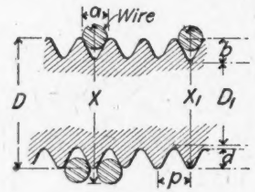
MEASURING SCREW THREADS.—III.

WHITWORTH THREAD



n = number of threads per inch
p = pitch = $\frac{1}{\text{no. of threads per inch}}$
d = depth of thread = 0.6403 p = $\frac{0.6403}{n}$
D = diameter on top of threads
D_1 = D − $\frac{1.6008}{n}$
a = diameter of wire { maximum diam. = 0.840 p / mininum diam. = 0.506 p
b = 1.08205 a
x = D_1 + 2b + a = D_1 + 3.1657 a
x_1 = $\frac{D}{2}$ + $\frac{D_1}{2}$ + b + $\frac{a}{2}$ = $\frac{D + D_1 + 3.1657a}{2}$

D	n	d	D_1	a	b	x	x_1
½	20	.0320	.1699	0.040	.0433	.2965	.2733
5/16	18	.0356	.2235	"	"	.3501	.3313
⅜	16	.0400	.2749	"	"	.4015	.3883
7/16	14	.0457	.3231	"	"	.4497	.4436
½	12	.0534	.3666	"	"	.4932	.4966
9/16	12	.0534	.4291	0.060	.0649	.6190	.5907
⅝	11	.0582	.4794	"	"	.6693	.6372
11/16	11	.0582	.5420	"	"	.7319	.7097
¾	10	.0640	.5899	"	"	.7798	.7649
13/16	10	.0640	.6524	"	"	.8423	.8274
⅞	9	.0711	.6971	"	"	.8870	.8810
15/16	9	.0711	.7596	"	"	.9495	.9435
1	8	.0800	.7999	0.100	.1084	1.1167	1.0583
1⅛	7	.0915	.8963	"	"	1.2131	1.1690
1¼	7	.0915	1.0213	"	"	1.3381	1.2940
1⅜	6	.1067	1.1082	"	"	1.4250	1.3999
1½	6	.1067	1.2332	"	"	1.5500	1.5250
1⅝	5	.1281	1.3048	0.150	.1624	1.7796	1.7023
1¾	5	.1281	1.4298	"	"	1.9046	1.8273
1⅞	4½	.1430	1.5193	"	"	1.9941	1.9345
2	4½	.1430	1.6443	"	"	2.1191	2.0595
2⅛	4½	.1430	1.7693	"	"	2.2441	2.1845
2¼	4	.1601	1.8498	"	"	2.3246	2.2873
2⅜	4	.1601	1.9750	"	"	2.4498	2.4123
2½	4	.1601	2.1000	"	"	2.5748	2.5373
2⅝	3½	.1830	2.2926	0.200	.2157	2.9240	2.8370
3	3½	.1830	2.5426	"	"	3.1740	3.0870
3¼	3½	.1970	2.7574	"	"	3.3887	3.3194
3½	3½	.1970	3.0074	"	"	3.6387	3.5694
3¾	3	.2134	3.2164	"	"	3.8477	3.7990
4	3	.2134	3.4664	"	"	4.0977	4.0490

Contributed by Walter Cantelo.

Y'S DATA SHEET.
Sheets
es solicited. Payment will be made for all accepted matter.
This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.